SCIENCE ABSTRACTS.

PHYSICS AND ELECTRICAL ENGINEERING.

AUGUST 1898.

GENERAL PHYSICS.

895. *Rigidity of Quartz Fibres.* **S. J. Barnett.** (Phys. Rev. 6. pp. 114–120, 1898.)—Quartz in the form of fibres of about 0·08 cm. diam. has a coefficient of rigidity at ordinary temperatures of about $1{\cdot}46 \times 10^{11}$. The coefficient does not vary with time. The coefficient *increases* with rise of temperature. A. Gs.

896. *Maximum Density of Alcohol.* **P. Moretto.** (N. Cimento, 4. 6. pp. 198–204, 1897.)—The author gives the maxima of density, obtained by De Coppet's method, of a number of solutions of methyl alcohol in water. For a 1 per cent solution this maximum occurs at 4°·14 C. For all other solutions it occurs at a lower temperature.
E. E. F.

897. *Density of Small Volumes of Gases.* **T. Schlœsing, Jnr.** (Comptes Rendus, 126. pp. 476–479 & 896–899, 1898.)—Gives some results of measurements with his gas manometer, which is 1460 times more sensitive than a water manometer. It consists of two long vertical tubes communicating at the top and bottom. One of them is divided into three parts by two side-tubes, which have many convolutions in a horizontal plane, so as to form a space in which gases can freely mix without affecting the main tube. The middle portion is filled with the gas to be examined, the bottom portion with CO_2, and the top and the entire other tube with air. As soon as the cock at the top is opened, equilibrium is established between the two tubes by a displacement of the imaginary surface of separation between the various gases. This surface of separation travels along the serpentine side-tubes, and does not affect the pressure or the composition of the gas in the main tube. The pressure is measured by letting

mercury into the other main tube and noting its level. The whole system forms a set of communicating tubes with one gas balancing three others in due proportions. The apparatus is useful for determining the densities of gases which, like argon, are only obtainable in small quantities, and also for investigating minute differences of pressure, as in a gas flowing along a tube. E. E. F.

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898. *Sun-spots and Variation of Magnetic Elements.* **W. Ellis.** (Roy. Soc. Proc. 63. pp. 64–78, 1898.)—The paper forms a continuation of one published previously on the same subject. The data are obtained for the period 1841–1896, the magnetic elements being derived from the Greenwich reports and the sun-spot data from those published by Prof. Rudolf Wolf. The three curves—number of sun-spots, diurnal range of declination, and diurnal range of horizontal force—are of the same general form, the maxima and minima occurring at the same time for all. The values of the maxima and minima also agree; thus, when there is an exceptionally high maximum in the sun-spot curve there is also an exceptionally high maximum in the declination and horizontal-force curves, and so on. The author concludes that these three phenomena must therefore be due to some common cause.

W. W.

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899. *Photography of Chromosphere.* **H. Deslandres.** (Comptes Rendus, 126. pp. 879–882, 1898.)—The author who, at the same time as Hale of Chicago, suggested that the violet lines H and K of calcium-vapour were bright in the spectra of faculæ, describes his arrangement for applying this fact to the problem of photographing the forms of faculæ and the chromosphere. The instrument, which he terms the "spectroheliograph," consists essentially of a spectroscopic train comprising slit, collimator, prism, and telescope, but with a second slit replacing the usual eyepiece at the focus of the telescope. This forms then an apparatus by means of which light of any desired wave-length can be isolated from the rest of the spectrum. An image of the sun is formed by a condensing-lens on the first slit, and a photographic plate placed close to, but not connected with, the second. If then the whole spectroscope is traversed so as to cause the first slit to cross the entire solar image, the light emerging from the second slit will print on the plate the images of whatever parts of the sun emit bright lines, viz. the lighter parts we call faculæ. In this way the author has got excellent plates showing the distribution of faculæ over the whole of the sun's disc. For the chromosphere, which is relatively feebler, the photosphere is obscured by means of a disc slightly larger than the visible image on the slit, and the rate of motion of the spectroscope lowered; and by this method the whole of the prominences etc. surrounding the sun are obtained at one exposure.

It is found that a great dispersion is not necessary, as the

K line of calcium is very broad and dark that it acts as a preventive to any other light passing through the second slit and so rendering the image obtained impure.

In his first apparatus, Deslandres used an image of the chromosphere 50 mm. in diameter, but has lately replaced the image-lens by one giving an image of 85 mm., so that details are much more clearly shown. He finds, from a study of the forms and numbers of the faculæ, that they follow a similar law to that so well known in the case of sun-spots. The photographs on the enlarged scale show much more of the grained structure of the solar surface, which has hitherto only been accurately portrayed by Gaussen. C. P. B.

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900. *Temperature of Europe.* **Van Rijckevorsel.** (Phil. Mag. 45. pp. 459–466, 1898.)—The author has drawn curves showing the mean values of the temperature for each day of the year, obtained from long series of observations, for many stations in Europe. He finds that there is a characteristic form of the curve for each station, which in some cases has persisted for two centuries, the characteristic curve varying from station to station, but in a regular manner. Some of the smaller maxima and minima are most astonishingly persistent and appear in the curves for many stations. The summer peak is very much flattened at stations on the Western coast, while it becomes steeper and steeper towards the Eastern portion of the continent. W. W.

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901. *Annual Range of Temperature at Rome.* **E. Bortolotti.** (Roma, R. Accad. Lincei, Atti, 7. pp. 121–128, 1898.)—The author discusses the values for the temperature at Rome during the years 1855–1894, and calculates what is the chance that the temperature of any particular month may differ from the mean value by given amounts. W. W.

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902. *Harmonic Analysis.* **E. J. Houston** and **A. E. Kennelly.** (Elect. World, 31. pp. 580–581, 1898.)—The method proposed by the authors depends on the following proposition:—If an odd number w of semi-wave-lengths of a simple sine curve be divided by straight lines perpendicular to the horizontal axis into p strips of equal width, and if p be >1 and prime to w, the difference between the sums of the areas in alternate strips is zero (*i. e.*, sum of odd strips—sum of even strips$=0$); if, however, $p=w$, *and the strips commence at the zero line*, then sum of odd strips—sum of even strips$=p$ times area of one semi-wave. From this is derived the following rule for analysing any graphically given wave into its simple harmonic components, say

$$A_1 \sin a + A_3 \sin 3a + A_5 \sin 5a + \ldots .$$
$$+ B_1 \cos a + B_3 \cos 3a + B_5 \cos 5a + \ldots .$$

To find any given coefficient, such as A_3, in the sine series, divide the curve into 3 equal strips, commencing at the zero point, and find the summation-difference S by planimeter, or by counting the number of little squares included in each strip. Then

$$A_3 = \pi S/L,$$

where L is the length of the given complete wave. Again, to find any coefficient in the cosine series, such as B_5, divide the semi-wave into 5 strips, *commencing at a point half a quintuple-frequency semi-wave-length from the zero point.* Then, S denoting as before the summation-difference,

$$B_5 = \pi S/L.$$ A. H.

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903. *The Jervis-Smith Tramway Chronograph.* (Engineering, 65. pp. 692–693, 1898.)—The tramway chronograph, whose name indicates the general construction of the instrument, measures the velocities of projectiles. A carriage, holding a smoked glass plate in a vertical position, rides on a rail about 5 feet long which is levelled by means of three screws. A tuning-fork and a number of styles are fixed on a special standard. Each style is carried by an aluminium arm attached to the armature of an electromagnet, which is released when the projectile passes through a screen. In order to use the instrument, the carriage is pushed home against a piston which stretches two spiral springs. On releasing the trigger, the carriage begins to run; it closes the firing circuit on its path, and is finally arrested by a brake strap of leather. When the records have been obtained, the times are measured by projecting with a T-square the breaks on the lines traced by the styles on to the time-record as traced by the tuning-fork. H. B.

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904. *Wave-Resistance of a Ship.* **J. H. Michell.** (Phil. Mag. 45. pp. 106–123, 1898.)—This paper gives a general solution of the problem of the waves produced by a ship moving with uniform velocity into deep still water, on the assumption that the ship is long and deep in comparison with its breadth. Practically, the solution obtained may be regarded as the first of a system of successive approximations which can be carried out in the same manner. A law of the resistance arising from the alteration of pressure on one element of the ship due to the disturbance created by another element is developed, and the result brought into comparison with the famous experimental results of the Froudes on the interaction of bow and stern waves. In connection with the resistance of high-speed boats, now attracting so much attention, it is proved that the wave-resistance in deep water ultimately vanishes as the speed is increased.

An example of the numerical calculation of the resistance of a ship of known form is appended, and there is also a simple theory given of a ship in shallow water. Author.

LIGHT.

905. *Propagation of Waves along a Periodically Loaded String.* **C. Godfrey.** (Phil. Mag. 45. pp. 356–363, 1898.)—The system considered consists of a heavy inextensible string under tension extending from $-\infty$ to $+\infty$. From $-\infty$ to 0 it is free from loads; from 0 to $+\infty$ it is loaded at equal intervals with equal massive particles. Simple transverse waves are travelling from $-\infty$; the steady vibration of the system is investigated. As the wave-motion continually impinges on the system of masses, some of it is reflected, some transmitted. It is found that the amount of transmission (and reflexion) depends on the wave-length in a discontinuous and quasi-periodic manner. The results may be stated in optical phraseology as follows:—A mixture of light of all wave-lengths impinges upon a solid of periodic structure. The light is analysed by a spectroscope after transmission through a considerable thickness. We shall find bright bands, narrow in comparison with the distances between them, their lower edges ranged harmonically; each band will be faint on the lower side and terminate abruptly at the upper edge. The width of the bands diminishes as we ascend the scale of frequency. Their lower edges correspond to the proper periods of the intermolecular spaces. If we view the light reflected, we shall find total reflexion corresponding to the frequencies of the dark bands of the transmission-spectrum; for these wave-lengths there will be reversal of phase on reflexion. In the above statement the word "light" must be taken to include radiation which lies outside the range of vision. AUTHOR.

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906. *Transparency of Bismuth in a Magnetic Field.* **H. Buisson.** (Comptes Rendus, 126. pp. 462–463, 1898.)—In the electromagnetic theory of light the transparency of bodies is linked with their electric conductivity, the coefficient of absorption being, to a first approximation, proportional to the square root of the conductivity. The author endeavours to find a variation of transparency in consequence of an intentional variation of the resistance of bismuth by means of a magnetic field. But experiments made with electrolytic bismuth in transparent sheets, exposed to a field of 15,000 units, which increases the resistance 60 per cent., fail to discover any variation of the transparency. It is evidently not the resistance to continuous currents or to slow oscillations which determines the opacity of a substance to light. E. E. F.

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907. *Hefner Lamp.* (Elect. Rev. 42. pp. 759–760, 1898.)—The article contains a detailed description, with illustrations, of the Hefner standard. Curves showing the variation of its intensity with barometric pressure and humidity are given. From these

it appears that such changes are under normal conditions extremely small. On the other hand, the intensity is much influenced by the amount of oxygen present in the air in which the flame is burning; hence the importance of using the standard in well-ventilated spaces. A. H.

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908. *Action of Metals etc. on a Photographic Plate.* **W. J. Russell.** (Chem. News, 77. pp. 167–170, 1898.)—The paper describes numerous experiments made to investigate the statement made in the Chem. News, 75. p. 302, that certain metals, copal, printing-ink, etc. had an action similar to light on a sensitised film. The active constituents of the organic bodies mentioned were found to be oil and turpentine. Further experiments showed that the following were active substances:—Vegetable and essential oils, paraldehyde, benzaldehyde, guiacum, cinnamon, spirits of nitre, eau-de-cologne, and terebene. The activity seems to depend on the reducing power: thus, linseed oil is very active, while olive oil, which has a far less reducing power, is only slightly so. Also oxidised bodies nearly related to the terpenes—such as terpinol, camphor, and thymol—are inactive. With some of these active bodies solarisation can be obtained. Among the metals, zinc, cadmium, magnesium, aluminium, and fusible metal are active; while lead, nickel, tin, silver, sodium, and mercury are inactive. A very slight trace (so small as one three-hundredth per cent.) of zinc is sufficient to make mercury highly active. Again, alcohol when pure is inactive, but after being in contact with zinc becomes active, this activity remaining after filtration and to a certain extent after distillation. Zinc after long exposure to the air is inactive, and is more active the cleaner its surface.

The experiments show conclusively that the action is due to a vapour emanating from the bodies; the active vapour can, for instance, be carried by a stream of air against the plate. Inactive substances such as cardboard can be impregnated with the vapour so as to become active. The vapour is capable of passing through sheets of various substances, such as gelatin, celluloid, collodion, goldbeaters'-skin, paper, tracing-paper, parchment, and gutta-percha. The transparency is the same to the vapour from the metals or from the other active bodies. Glass, selenite, and mica are quite opaque to the action.

To test the porosity of the transparent substances, the power of hydrogen to diffuse through them was tried. Diffusion takes place through tracing-paper and goldbeaters'-skin; but through thin gelatin and celluloid there was no sign of diffusion until after three days. Increase of temperature greatly increases the activity of both the metals and the organic bodies. The time of exposure in the experiments varied from a day to two months. G. H. Ba.

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909. *Photographic Development.* **R. Colson.** (Comptes Rendus, 126. pp. 470–473, 1898.)—The effect of touching the

sensitive plate with the hand or with any warm conductor during development is to produce streaky black marks, due to acceleration of the developing process at the points touched, and diffusion from the more concentrated developer. This diffusion may also take place at the border between a very bright and a very dark portion of the image, since the developer above the dark portion is attenuated, and then rehabilitated by diffusion. Hence the dark portion is blackest at the border, where the developer is fed from the white portion. This happens when the developer is either very rapid or is allowed to stand. The author studies the effect in detail. Some supposed Röntgen-ray effects may possibly be attributable to this source of error. He describes a process of "confined development" where the plate is covered by a thin layer of developer surmounted by a glass plate. The result is to harden the contrasts, which is useful in line drawings. E. E. F.

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910. *Radiation Phenomena in a Magnetic Field.* **T. Preston.** (Phil. Mag. 45. pp. 325–339, 1898.)—Gives a general account of the modifications which the spectral lines of various substances suffer when the source of light is placed in a strong magnetic field. The paper is accompanied by a plate, reproduced from an actual photograph, of the spectral lines of cadmium and zinc. This plate shows the triplets formed when the radiation travels across the lines of force, and the doublets formed along the lines of force as well as the polarisation of the constituents of the triplets. In addition, some of the modified lines show as quartets across the lines of force. This and other deviations from the normal triplet type of effect are considered in the paper, and are thought to be sufficiently accounted for as the effects of absorption in the outer vapour of the spark; but this point is not considered as conclusively established.

Measurements are given which show that the quotient e/m is not constant, but is some function of the wave-length not yet determined, or else it possesses a set of values for each substance which correspond to sets of spectral lines, the grouping of which has not yet been effected. Gases and magnetic substances are also considered and other details are given in the paper, which must be referred to for fuller information. AUTHOR.

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911. *Zeeman Effect.* **A. Garbasso.** (N. Cimento, 4. 6. pp. 8–14, 1897.)—Instead of postulating an action on the electrons, the author supposes that the magnetic field acts directly upon the vibrating atoms, producing a kind of damping effect. This widens the spectrum line into a band, with polarised edges. In the case of rays proceeding along the lines of force, they must traverse the air contained in the perforation of the magnet-pole, which is in an optically active state. The rays, to begin with, are plane-polarised, and their vibration may be considered as the

resultant of two circular vibrations in opposite directions. One of these is accelerated by the air, and the other is retarded, giving rise to the edges circularly polarised in opposite directions, as observed by Zeeman. E. E. F.

912. *Röntgen Rays.* **G. G. Stokes.** (Mem. & Proc. Manchester Lit. & Phil. Soc. xli., 1897.)—The method of ascertaining the source of Röntgen rays by finding the points from which the directions of Röntgen rays (as determined by means of shadows) apparently diverge is not conclusive: as an experimental fact, the Röntgen radiation is more abundant along the normals to the fluorescent surface than in any other directions; but it does not follow that their source is the point where these normals, if produced backward, converge. Röntgen appears to have correctly stated that the rays come from the place where the kathode rays strike the glass.—Röntgen rays seem to travel in the ether; but how? The transparency of so many opaque substances to them would not be of great consequence if it stood alone: the distinct outlines of shadows and the absence or almost complete absence of diffraction raise the question of transversal or longitudinal vibrations. Polarisation would show the vibrations to be transversal: the apparent absence of it with tourmalines is not conclusive; and polarisation by reflexion is not available. Becquerel's rays being polarisable, Galitzin and v. Karnojitski having obtained some indications of polarisation with Röntgen rays, and Green's argument against the existence of longitudinal vibrations in the ether being as valid in the case of Röntgen rays as in that of light, the conclusion is that the perturbations are transversal.—The kathode rays are the parents, so to speak, of the Röntgen rays: these are either molecular streams or perturbations propagated in the ether. Kathode rays are usually slightly visible from one side (unless the rarefaction is extreme) as a faint blue light: this might be due to ether-perturbations encountering molecules. But the difficulties of the ether-theory are extreme: the mechanical effect of the kathode rays, their rectilinear course at right angles to the kathode, their deviation by electric, magnetic, and electrodynamic forces. The principal difficulties of the molecular-stream theory are:—(1) Kathode rays will not pass through extremely high vacua; but kathode rays passing through lower vacua will, after passing through aluminium, continue their course (Lenard) in the highest vacua. Lenard thinks the highest vacua may be considered as perfect vacua; the author does not: there is always a blue halo round the bright patch on the phosphorescent screen, and there is always some effect analogous to opalescence; the vacuum is not perfect. (2) How could kathode rays, if molecular, pass through an aluminium window? It is not absolutely clear that they do: compare a sheet of copper inserted between the electrodes in an electrolytic cell; the second surface of the aluminium window may act as a fresh kathodic surface.—The deviation of the kathode rays by electric etc. forces is difficult to explain on the ether theory, but

is quite natural on the material theory, for a charged molecule at a high velocity acts like a current and is similarly attracted or repelled.

Adopting, then, the molecular-stream theory, each molecule, when it impinges on the antikathode, produces a perturbation of the ether, either through its momentum or through its static charge (whatever that may really mean); and the perturbation is propagated through the ether in all directions, in a spherical wave if the medium be indefinite, and transversal if the medium be not compressible. Now, instead of considering undulatory or periodic disturbances, consider one single pulsation: this consists of two half-waves which need not be identical, but the integral of the perturbation in one direction must be equal and of opposite sign to the integral of the perturbation in the opposite direction. Of such single pulsations, a succession of them, independent of one another, each starting from the point where a molecule from the kathode has jolted against the antikathode—of such may Röntgen radiations be made up. The numbers of such pulsations or single throbs would be immense even at the highest vacua obtainable. This conception enables us to explain the characteristic features of Röntgen rays:—I. *The absence of diffraction*, or rather its almost entire absence. In a single pulsation the absence of diffraction will be more complete the greater the obliquity and the less the thickness of the portion of the ether disturbed by the passing wave. If then the perturbation of the ether caused by the impact of the molecules against the antikathode lasts only for an extremely short time, a very small fraction of the period of a light-wave, so that the pulsation-wave may be considered extremely thin, there will be no sensible propagation in any direction other than the normal, and therefore there will be no diffraction. (The differences—penetrating power, absorbability—between Röntgen rays from different sources would be explained by differences between the times during which the perturbation continues and corresponding differences between the thicknesses of the part of the ether disturbed by the passing wave. When the vacuum is very high, the molecules probably reach the antikathode with higher velocities and the resultant perturbation is more abrupt: then the penetrating power of the wave is greater.) The same explanation accounts for the sharpness of the shadows: periodicity of the perturbations is not necessary. II. *The absence of refraction*, or rather its immeasurable smallness. This has led the author to a new theory of refraction. Give up the idea that refraction occurs *immediately* on light entering a prism; assume the relation between molecules of ether and molecules of ordinary matter to be like that between a string and a massive sounding-board: then the etheric vibrations are hampered in their course by passing among the molecules which they tend to set in motion. Some time will pass before the molecules are set fully in motion; and according to the period and the direction in which the molecules are successively set in vibration, there will be some mode of movement which the system

spontaneously tends to take up, and all other movements will tend to die away continuously while the former will be maintained. After say 100,000 vibrations (=say 1/40,000,000,000 second), the molecules of the glass will all be vibrating harmonically with those of the ether. In the Röntgen rays considered as consisting of independent pulsations, there would be no chance of this kind of harmony being established. In the case of light, the kinetic energy would be partly in the ether, partly in the matter; and for each period, each wave-length, the energy should be the same in the glass and in the air outside the glass; but this cannot be unless the wave-length is shorter in the glass. In a transparent substance a permanent condition is reached; in an opaque one it is not, but the movements of the molecules are continuously being handed on to other molecules: these differences are not such as to make any difference to Röntgen rays.—Becquerel's rays stand between light and Röntgen rays. These rays, from metallic uranium, traverse black paper so as to affect a photographic plate; and they can discharge a static charge. The molecule of uranium has seemingly a constitution like that of a flexible chain supporting a small weight: vibrations communicated to the top become far from true harmonic ere reaching the small weight. This gives the idea of perturbations neither successively single like Röntgen rays, nor truly harmonic like light, but partaking of the nature of both, irregular enough to go through black paper and regular enough to be refracted. These rays can be polarised.

[For French translation, with mathematical proofs, see *Ecl. Électr.* 14. pp. 374–387, 1898.] A.D.

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913. *Evidence that Röntgen Rays are Ordinary Light.* **G. J. Stoney.** (Phil. Mag. 45. pp. 532–536, and 46. pp. 253–254, 1898.)—This enquiry is based upon Sir George Stokes's explanation of Röntgen rays, which amounts to this,—That kathode rays consist of negatively charged missiles, shot in showers like hedge-firing from the negative electrode against a target which receives and suddenly arrests them; and that the Röntgen rays are due to the independent pulses propagated through the ether when the advances of their negative charges are thus abruptly stopped or altered. According to this view, the radiation from the target reaches the object which is being skiagraphed as an undulation consisting of irregular pulses. The present inquiry is as to what part of this irregular undulation can pass through the object and arrive at the fluorescent screen beyond. This is ascertained by showing that the undulation of irregular pulses can be resolved into trains of waves of different wave-lengths, among which waves of short wave-length are abundant if the hedge-firing have been sufficiently violent and irregular. The resolution is effected by combining MacCullagh's method of analysis with Fourier's in such a way as secures that the resolution is a physical one, and not merely kinematical. The radiation which traverses

the space between the target and the object becomes thus the same physical event as the coexistence in that space of the trains of waves of various wave-lengths indicated by this method, which are such that each train has an actual physical existence and advances through the ether independently of the rest. All these constituent trains encounter the object, which is of such a kind that it is opaque to those of longer wave-length, while it allows those of short wave-length to pass on and reach the fluorescent screen. These, accordingly, are what produce the Röntgen effect. The more violent, abrupt, and irregular the hedge-firing, the more abundant will these essential constituents of short wave-length be.
AUTHOR.

914. *Distortion in Sciagraphy.* **O. L. Schmidt** and **W. C. Fuchs.** (West. Electn. 22. p. 180, 1898.)—With a focus-tube 11 inches long, 4 in. in diameter, and 6 in. between electrodes, if F be the distance of a point in the object from the focus line of the tube, P the distance of that point from the sensitive plate, then the distortion D in the image of that point is, when the distance between the tube and the plate is 50 cm., equal to (0·022433 FP) cm.
A. D.

915. *Crypto-luminescence of Metals under Röntgen Rays.* **A. Rôiti.** (Roma, R. Accad. Lincei, Atti, 7. pp. 87–91, 1898.)—Certain metals appear to have different permeabilities to Röntgen rays according to their distance from the vacuum-tube. This is due to a transformation into "crypto-luminescent" rays, which are more readily absorbed by air than the Röntgen rays which give rise to them.
A. D.

916. *Diffusion of Röntgen Rays.* **R. Malagoli** and **C. Bonacini.** (Roma, R. Accad. Lincei, Atti, 7. pp. 96–104, 203–210, 1898.)—Experiments tending to show that the influence of the intervening air as a diffusive reflector is extremely small, and that the apparent bending of Röntgen rays is due to the action of surrounding bodies mainly, these surrounding bodies acting as diffusive reflectors, and doing so equally well in powder or as solids. Substances of greater specific weight transform the character of Röntgen rays incident upon them: substances of small specific weight act simply as diffuse reflectors: while those of intermediate specific weight produce intermediate results. Mercury is the only liquid which has the former of these effects.
A. D.

HEAT.

917. *Fusing-Points of Silver and Gold.* **D. Berthelot.** (Comptes Rendus, 126. pp. 473–476, 1898.)—A platinum-platino-iridium thermocouple is mounted in the neighbourhood of a platinum circuit with a silver or gold wire inserted in it. At fusion of the wire the current is broken. The temperatures indicated by the thermocouple are 962° for silver and 1064° for gold. The majority of previous determinations also give a difference of 102° between the two fusing-points. E. E. F.

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918. *Fusing-Point of Aluminium-Antimony Alloy.* **E. van Aubel.** (Journ. de Phys. 7. pp. 223–224, 1898.)—Referring to the results obtained by Roberts-Austen and C. R. A. Wright in their experiments on the fusing-point of alloys and the anomalies of gold-aluminium and aluminium-antimony when alloyed, the author repeats the experiments on the formation of an alloy corresponding to AlSb, which Wright found did not solidify below 1000° C., this being very remarkable, since aluminium melts at 600° and antimony at 440°. M. Heraeus of Hanau prepared this alloy with specially pure metals sent to him by the author, and the point of fusion was determined by means of the thermoelectric pyrometer of Le Chatelier, which was standardised at the Physico-technical Institute of the German Empire. The two metals are melted in a crucible of graphite containing fused chloride of sodium to preserve them from oxidation. The product obtained after cooling presents two surfaces whose aspect is very homogeneous. The measurements of the fusing-point give 1078° to 1080° C. Different portions of the same mass were taken, in order to insure homogeneity of the alloy by the constancy of the point of fusion. J. J. S.

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919. *Laws of Perfect Gases.* **G. Bakker.** (Journ. de Physique, 7. pp. 152–154, 1898.)—Any one of the laws of Boyle, Charles, and Joule may be deduced with the help of thermodynamics from the other two. Two proofs are given; the simpler is as follows:—

If $f(p, v, T)=0$ is the equation of condition of a gas,

$$\left(\frac{\partial p}{\partial T}\right)_v \cdot \left(\frac{\partial T}{\partial v}\right)_p \cdot \left(\frac{\partial v}{\partial p}\right)_T = -1$$

or

$$\frac{T}{p}\left(\frac{\partial p}{\partial T}\right)_v \cdot \frac{v}{T}\left(\frac{\partial T}{\partial v}\right)_p \cdot \frac{p}{v}\left(\frac{\partial v}{\partial p}\right)_T = -1.$$

Boyle's law, in the form $pv=f_1(T)$, gives

$$\frac{p}{v}\left(\frac{\partial v}{\partial p}\right)_T = -1.$$

Charles' law $\left(v=T\phi(p)\right)$ gives

$$\frac{T}{v}\left(\frac{\partial v}{\partial T}\right)_v = -1.$$

Joule's law, $\epsilon=f_2(T)$, gives

$$\left(\frac{\partial \epsilon}{\partial v}\right)_T = 0.$$

But

$$\left(\frac{\partial \epsilon}{\partial v}\right)_T = T\left(\frac{\partial p}{\partial T}\right) - p.$$

Therefore

$$\frac{T}{p}\left(\frac{\partial p}{\partial T}\right)_v = 1.$$

T. E.

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920. *Isothermals of Ether.* **J. Rose-Innes.** (Phil. Mag. 45. pp. 102–106, 1898.)—This paper attempts to deal with the experimental material acquired by Ramsay and Young in their study of ether (Phil. Trans. vol. 178. A. pp. 57–93, and Phil. Mag. vol. 23. pp. 435–458). The conclusions arrived at are as follows:—

(1) If we denote the internal pressure by a, there is an extremely rapid change in the slope of $\frac{1}{av^2}$ when plotted against $v^{-\frac{1}{3}}$, in the neighbourhood of vol. 3·3. This is shown by means of a diagram.

(2) The temperature for which the pressure is accurately given by the laws of a perfect gas at a given volume remains practically constant until the neighbourhood of the critical volume is approached.

Similar conclusions had already been arrived at for isopentane. These conclusions are embodied in a formula giving the pressure in terms of the temperature and volume, and a comparison between calculation and experiment is then instituted. AUTHOR.

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921. *Latent Heat of Evaporation.* **Louguinine.** (Annal. Chim. Phys. 13. pp. 289–377, 1898.)—The chief theoretical interest in the paper lies in the examination of Trouton's Law, which states that ML/T is a constant, where M is the molecular weight of the substance, L the latent heat of evaporation, and T the boiling-point measured on the absolute scale. The determination of the latent heat by the method adopted by the author requires a knowledge of the specific heat and the boiling-point at various pressures; and in the earlier part of the paper he deals with the obtaining of these quantities. He has studied: (1) the

GROUPS (1), (2), & (6).

Name of substance.	Ethyl Alcohol.	Propyl Alcohol.	Iso-propyl Alcohol.	Butyl Alcohol.	Isobutyl Alcohol.
Limits of temp. .	77° to 19°·5	90°·1 to 21°·5	80° to 21°	114°·5 to 20°·5	108°·109 to 21°
Mean Sp. H.	0·643	0·675	0·7064	0·3888	0·7159
B.P. Centigrade...	78·2	97·2	82·04	117·02	107·53
d	0·036	0·038	0·035	0·0386	0·036
L	201·47	160·97	157·82	137·87	134·34
ML/T	26·39	26·09	26·5	26·16	26·12

GROUP (2).

Name of substance.	Methylethyl Ketone.	Diethyl Ketone.	Methylisopropyl Ketone.
Limits of temp. ...	77°·5 to 20°	98°·5 to 20°	91°·5 to 20°
Mean Sp. H.	0·5493	0·5572	0·5251
B.P. Centigrade.....	78·6	101·08	92·40
d	0·056	0·046	0·046
L	103·77	90·90	89·87
ML/T	21·25	20·90	21·15

GROUP (3).

Name of substance.	Diethyl-oxalic Ester.	Diethyl-carbonic Ester.	Dimethyl-carbonic Ester.	Acetal.
Limits of temp. .	185° to 23°·8	123° to 20°·2	88° to 19°·8	99° to 19°
Mean Sp. H.	0·4752	0·4745	0·4521	0·5198
B.P. Centigrade...	185·19	125·74	89·7	102·91
d	0·051	0·048	0·043	0·046
L	68·77	73·07	88·26	66·2
ML/T	21·91	21·62	21·85	20·78

GROUPS (1), (2), & (6).

Amyl Alcohol. *	Tertiary Amyl Alcohol.	Active Amyl Alcohol.	Allyl Alcohol.	Glycol.	Benzyl Alcohol.
129°·9 to 21° 0·6955	98°·5 to 20° 0·7534	125°·128 to 21°·5 0·7115	95°·5 to 20°·5 0·6654	188° to 22° 0·6621	200° to 22° 0·5402
130·11	101·81	.....	96·69	197·37	205·35
0·0399	0·039	.....	0·037	0·048	0·056
115·91	106·08	113·66	163·29	194·49	101·44
25·30	24·91	24·88	25·63	25·64	22·90

* By fermentation.

GROUP (2).

Methylbutyl Ketone.	Dipropyl Ketone.	Methylexyl Ketone.	Benzoic Aldehyde.
126°·5 to 21° 0·5528	140° to 20°·5 0·5520	168° to 21°·7 0·5523	172° to 22° 0·4281
127·37	143·52	172·92	178·9
0·049	0·048	0·052	0·055
82·35	75·73	74·17	89·23
20·57	20·73	21·29	20·93

GROUP (4).

Name of substance ...	Octane.	Decane.	Benzene.
Limits of temp. ..... Mean Sp. H.	123° to 20°·5 0·5792	154° to 21°·5 0·5899	77°·2 to 19°·3 0·4349
B.P. Centigrade	125·30	159·66	80·20
d	0·048	0·046	0·043
L	70·84	60·06	92·97
ML/T	20·28	19·7	20·53

saturated alcohols of the fatty series, as well as unsaturated allyl alcohol; (2) the ketones of the fatty series and the oxide of mesityl, which can be regarded as an unsaturated ketone; also benzoic aldehyde; (3) the neutral esters of the dibasic acids, carbonic and oxalic, as well as acetal; (4) octane, decane, and benzene; (5) ethylene glycol; (6) benzene.

Some of the results are given on pp. 482–3, where T indicates the boiling-point under standard conditions, and *d* the variation of the boiling-point for a change of 1 mm. of mercury in the pressure. The author observes that the values of ML/T not only vary from one group of chemical substances to another, but also, although to a much smaller extent, within the limits of the same group; nevertheless, these variations are not so great that they prevent the calculation of the latent heat of evaporation of the substances composing a group. A. Gs.

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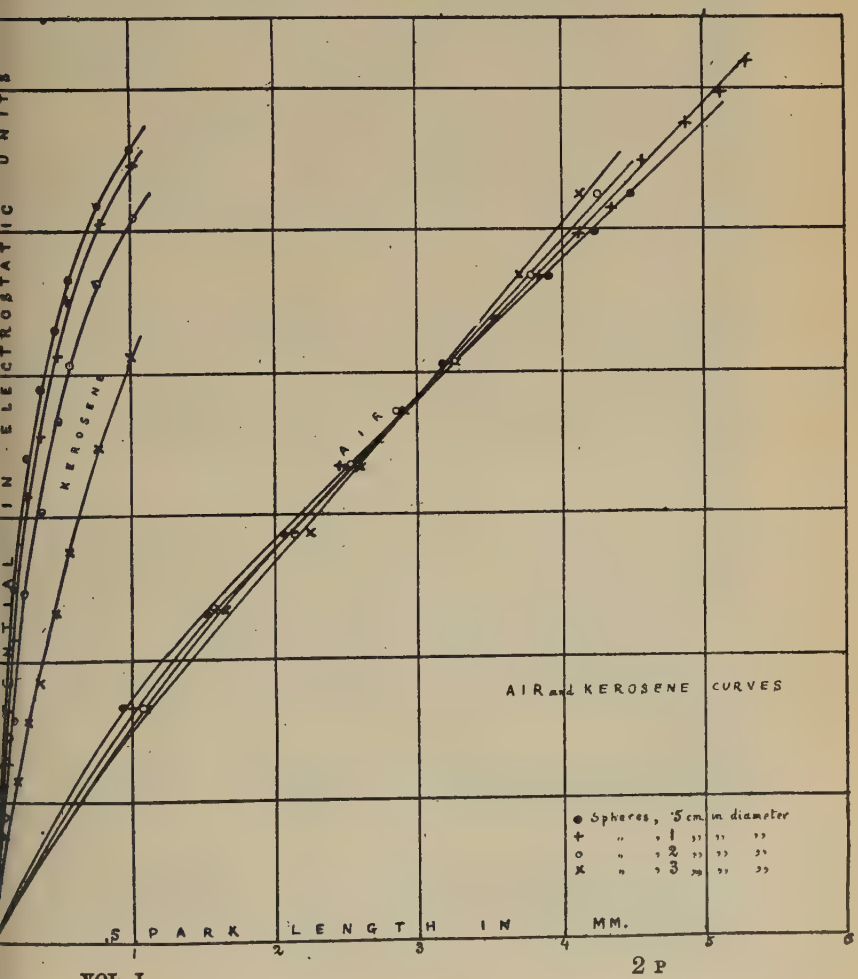
922. *Liquid Air.* (Eng. News, 39. pp. 245–247, 1898.)—A brief account is given of the apparatus devised by **C. E. Tripler** for liquefying air. An air-compressor rated at 60 H.P. is used, driven by steam, and consisting of three water-cooled cylinders in tandem, in addition to the steam-cylinder. Atmospheric air is drawn through a dust-separator and raised in three stages to a pressure of 2200 lbs. per sq. in. The air is then passed through cooling tanks and drying apparatus to the "liquefier," which is not described in detail, but of which the action is as follows:—Air entering at the upper end of the liquefier under a pressure of 2200 lbs. per sq. in. passes downwards through coiled pipes to the lower end, where it escapes through reducing-valves; the sudden expansion cools the air, which, in rising amongst the pipes to an outlet at the top, further cools the in-coming air within the pipes. The cooling action is therefore cumulative, so that after the apparatus has been at work about 20 minutes the temperature is reduced below $-220°$ F. and liquid air begins to collect at the bottom of the liquefier; from thence it may be drawn off through a valve. An output of 3 or 4 gallons per hour is said to be attained with ease.

A comparison is drawn between this apparatus and those of Linde (Abstract No. 774) and Hampson; and it is stated that the probable cost of production is about $7\frac{1}{4}d.$ per gallon, exclusive of interest on capital etc. On allowing 95 % of the liquid to evaporate, the residue contains 90 % of the oxygen originally present, in the proportions of 88 parts oxygen to 12 parts nitrogen. The liquid may be transported by rail, in well-lagged open vessels, without difficulty. Various uses have been suggested for the product, chief of which are refrigeration and blasting. Several interesting phenomena and experiments with liquid air are briefly described. A. H. A.

ELECTRICITY.

923. *Spark Discharge in Air and Liquid Dielectrics.* **T. W. Edmondson.** (Phys. Rev. 6, pp. 65–97, 1898).—For measuring the sparking potential difference between the two electrodes, the author uses an attracted-disc electrometer. The disc (which is provided with a guard-ring) is suspended from one arm of a balance, a portion of the suspension consisting of a quartz fibre. The other arm is loaded with any desired weight (depending on the potential difference which it is desired to obtain), the



beam being checked so that the pointer is at the first scale-division to the right of the zero. The electrometer and spark-gap being connected in parallel with each other and with a leyden, the handle of a Wimshurst machine which supplies the potential difference is turned as uniformly as possible, while the distance between the electrodes is adjusted by means of a micrometer until, at the passage of a spark, the pointer of the balance just moves to the left. Spherical electrodes were used in every case, and the dielectrics experimented on comprise air and a large number of the insulating oils. The results for air and kerosene are plotted in the accompanying curves. The air-curves show clearly that, while a smaller difference of potential is necessary to produce a discharge through a given distance for large spheres than for small ones when the spheres are *close together*, for greater distances the dielectric is electrically stronger for the large than for the small spheres. Whether the same results hold for the insulating oils the present experiments do not show, as it was impossible to obtain consistent readings for spark-lengths of more than 1·4 mm., on account of the great disturbance of the liquid due to convection-currents. When experimenting with the oils it was found impossible to obtain satisfactory results with the electrometer; the number of sparks which had to be passed before a satisfactory throw of the balance was obtained being so great, that the electrodes became coated with carbon and a chain of carbon particles was formed between them. Hence the electrometer was replaced by two spherical electrodes (1 cm. diam.), the distance between which was gradually increased until the spark preferred to pass through the oil, the potential difference being deduced from the known results for spherical electrodes in air. Results obtained with an alternating discharge (from an induction-coil) are also given; these, however, are somewhat erratic. A. H.

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924. *Retardation of Point Discharges.* **K. Wesendonck.** (Annal. Phys. Chem. 65. 1. pp. 116–122, 1898.)—The fact that negative discharge-potentials in hydrogen are higher than the positive ones has been attributed to a retardation; and it has been suggested that the maintenance for some time of the needle at a lower difference of potential might lead to a better value. After every precaution is taken, the average negative potentials are slightly less than the average positive ones, the former varying between −1350 and −1500 volts, and the latter between 1450 and 1500. The deposition on the needle of an invisible amount of mercury is capable of increasing the negative discharge-potential to 2000 volts. E. E. F.

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925. *Static and Dynamic Spark-Potentials.* **R. Swyngedauw.** (Journ. de Physique, 6. pp. 465–472, 1897.)—The frequency of the sparks, the state of polish of the electrodes, the presence of ultra-violet light, and the influence of X-rays affect in a different

manner the difference of potential necessary for a slow (static) discharge and for a sudden (dynamic) discharge. In the usual arrangements for determining the critical distance, the dynamic spark-potential is generally different from the static spark-potential. According to the accidents of the experiment, it is larger or smaller or equal to it, and the difference can attain a notable fraction of the spark-potential. But with suitable precautions, designed to eliminate the disturbances mentioned, the two discharge-potentials may be shown to be equal in every case. E. E. F.

926. *Arc Prevention by Subdivided Break.* **A. J. Wurts.** (Elect. World, 31. p. 498, 1898.)—The article deals with the *modus operandi* of a multiple-break switch, the breaks being arranged in series so as to subdivide the arc. It has been stated by some writers that the arc is extinguished by the cooling effect of the electrodes. The author denies this, pointing out that when once an arc is established between two metallic surfaces, any conduction of heat which may subsequently take place is not found to appreciably affect the arc. He maintains that the action of a subdivided break is nothing more than the gradual introduction of the resistance and counter-E.M.F. of the individual arcs formed in succession as the circuit is opened. A. H.

927. *Dispersion of Kathode Rays.* **J. R. von Geitler.** (Annal. Phys. Chem. 65. 1. pp. 123–140, 1898.)—A flat kathode is placed at one end of a long vacuum-tube, and a wire kathode near the other end. The anode is in a side-tube between the two. When the two kathodes are joined by a wire, and the tube is excited by means of an induction-coil, the shadow of the wire appears broadened out, owing to electrostatic deflection. On inserting a condenser between the two kathodes, fringes appear on the walls of the tube, ranging in number from two to seven, the number being increased by increasing the capacity of the condenser or the pressure of the gas. The fringes are not due to interference, but to the fact that the condenser sends out successive trains of rays of decreasing intensity, each of which is deflected more than the previous one. A similar effect may be produced by magnetic deflection, the tube being half filled up by a semicircular metallic screen. E. E. F.

928. *Ortho-kathodic Rays.* **A. Sandrucci.** (Roma, R. Accad. Lincei, Atti, 7, pp. 104–108, 1898.)—Both electrodes give off ortho-kathodic rays, the kathode more powerfully: in two cones of radiation (under a certain exhaustion) similarly affected by the magnet. The violet light of the anode reacts to the magnet as if it were a rectilinear electric current passing *from* the anode to the anti-anode. A. D.

929. *Deflection of Canal Rays.* **W. Wien.** (Berlin. Phys. Gesell. Verh. 17. pp. 10–12, 1898.)—A hole 2 mm. in diameter is bored in a metal plate, and glass tubes are cemented on to it on both sides. Into one of the glass tubes an anode is inserted, while the other carries two electrodes producing an electrostatic field. At a proper exhaustion, a bundle of canal-rays emerges from the hole, producing a fluorescent patch of the well-known yellow-brown colour on the wall of the tube. A difference of potential of 2000 volts, produced by a high-potential accumulator, produces a deflection of 6 mm. towards the negative electrode. For producing magnetic deflection, the magnetic influence of the induction-coil on the kathode rays must be shielded off by enclosing the anode tube in an iron cylinder. Then the canal-rays are clearly deflected, to the extent of 6 mm. for a field of 3250. The velocity of the canal-rays is calculated at $3{\cdot}6 \times 10^{7}$, and the ratio of the mass to the charge at $3{\cdot}3 \times 10^{-3}$. E. E. F.

930. *Specific Inductive Capacity of Oils.* **A. L. Clark.** (Phys. Rev. 6. pp. 120–125, 1898.)—By Quincke's bubble method the author finds that for ordinary kerosene the specific inductive capacity equals 2·22; for water white 150°, 2·23; export distillate, 2·06; xylol, 2·34; benzol, 2·38; paraffin oil, 2·71; white castor oil, 4·92; neatsfoot oil, 3·22; cottonseed oil, 3·88; sweet neutral oil, 2·36; high gravity oil, 2·12; olive oil, 3·52. A. Gs.

931. *Electric Resistance of Cobalt, Iron, and Nickel in Magnetic Fields.* **J. C. Beattie.** (Phil. Mag. 45. pp. 243–253, 1898.)—The films are deposited on platinised glass by electrolysis. The resistance of cobalt increases with increase of field, initially the variation being directly as the square of the strength of the field. Roughly, the Hall-effect varies as the square root of the increase in the resistance. The behaviour of nickel is different with different specimens, and even with the same specimen at different times. "In all the mirrors, however, the variation of resistance shows signs of attaining a maximum, but at a higher field than that required for the Hall-effect maximum." With iron films the variation of resistance is so small as to be difficult to measure. Its variation is probably less than proportionality to field squared would lead us to expect. A. Gs.

932. *Insulation-Test for Cable-Joints.* **E. Raymond-Barker.** (Elect. Rev. 42. p. 610, 1898.)—The author applies the principle of the "method of mixtures" to ascertain the resistance of a joint in gutta-percha or other core. Electrical connections are arranged as in the "Thomson" capacity test, the two ratio-resistances being replaced by two short lengths of core submerged in water. One of these lengths contains the joint to be tested, the other is a piece of similar core of equal length without a joint. Two standard

mica condensers, each of 1 mfd., are used for the capacity-ratios. The quantity of electricity that leaks into either condenser in a given time, say one minute, depends upon the dielectric resistance of the corresponding piece of core. If the joint on that side is faulty, the defect shows itself when the galvanometer key is depressed. This test has all the advantages of a *null* method; it requires only the ordinary apparatus of core-testing, and it appears to be more expeditious than previous joint tests. R. A.

933. *Conductivity of Electrolytes for Small E.M.F.'s.* **H. Danneel.** (Zeitschr. Elektrochem. 4. pp. 211–213, 227–232, 1897.)—An E.M.F. insufficient to decompose continuously an electrolyte gives rise to a small continuous current through it. In the case of dilute sulphuric acid, Helmholtz explained this by the depolarising action of the hydrogen and oxygen dissolved in the liquid. The author calculates the magnitude of the current in this case when the stationary condition is attained. If, for example, the solution is saturated with hydrogen under a given pressure, the passage of the current between the platinum electrodes increases the concentration of the hydrogen at the kathode and diminishes it at the anode (owing to the action of the oxygen evolved there). Hydrogen then diffuses from the kathode to the anode, and a stationary condition is attained when the quantity of hydrogen liberated at the kathode just balances the loss by diffusion. The rate of diffusion is calculated by Fick's equation, and the fall of concentration between the electrodes corresponding to a given E.M.F. applied to them by Nernst's theory. The combination of these two equations gives an equation from which the value of the steady current which is obtained when the distribution of the dissolved gas between the electrodes has become constant may be calculated. From this equation it follows that the current should be proportional to the pressure of the gas with which the solution is saturated, and that it increases with the applied E.M.F. at first rapidly, afterwards slowly. Experiments with platinised platinum electrodes and dilute sulphuric acid saturated with hydrogen, gave values for the current about three times those calculated when the electrodes were 0·1 or 0·73 cm. apart; when they were 26 cms. apart the current diminished slowly, but after 4 days was still about 50 times the calculated value. Similar results were obtained with oxygen. The current decreases when the pressure of the gas is diminished, but more slowly than the latter. When the concentration of the depolarising nonconducting substance is large, the electrolyte behaves much in the same way as a metallic conductor. This was proved experimentally with a solution of iodine in potassium iodide. T. E.

934. *Thomson and Varley Slides.* **A. Tobler.** (Journ. Télégraph. 22. pp. 4–9, 1898.)—This is a very complete account of the development of the Thomson and Varley slide-bridge, compiled from various sources, to which references are given. R. A.

935. *Electrical Alloys.* **R. Appleyard.** (Elect. Rev. 42. pp. 607–610, 1898.)—This is a continuation of the article referred to in Abstract No. 806. It describes the Reichsanstalt experiments on copper, nickel, and other metals; and the effect of the quantity of nickel upon the temperature coefficients. The results are presented graphically by curves, giving the temperature-coefficient, the specific resistance, the thermoelectric force (against copper), and the chemical constitution of twelve different specimens. In the discussion of results it appears that there are two alloys of this class, both of which have vanishing temperature coefficients. These two alloys are "manganin" and "constantan." Important as is the production of an alloy possessed of a vanishing temperature-coefficient, such an alloy cannot be adopted for standard coils until the permanence of the specific resistance has been established. This being done, preference has next to be given to the alloys of least thermoelectric power (against copper). From a table of figures accompanying the curves, it is seen that manganese-copper has only small negative values of thermoelectric power (against copper); this can be got rid of by adding a trace of nickel. But nickel-copper, and especially constantan, has high thermoelectric power (against copper), and is unsuitable for coils intended for measurements of precision. Manganin would thus appear to be better for all purposes than constantan, but unfortunately manganin is rather easily oxidised. At 100° C. the wire soon tarnishes; during annealing, the surface manganese is perceptibly oxidised out of the alloy, leaving a skin of copper beneath the oxide. The electrical qualities suffer in consequence. Wire-drawers have now learnt how to drawn manganin cold, even to fine gauges. Shellac-varnish is very effective protection. Constantan, on the other hand, resists oxidation. It can be heated with impunity up to 300° C. The article concludes with some details as to the soldering of these wires. AUTHOR.

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936. *Condensers for Induction Coils.* **P. Dubois.** (Annal. Phys. Chem. 65. 1. pp. 86–91, 1898).—As already pointed out by Walter, the utility of a condenser in increasing the E.M.F. in an induction-coil ceases when the capacity of the condenser surpasses a certain value. The author determines the most useful capacities for secondary circuits of various resistances. These capacities vary from 3 microfarads for 225 ohms to 0·2 microfarad for 5225 ohms in the secondary circuit. The insertion of 10 microfarads stops all physiological action of the secondary current. The author's measurements were carried out with an electrodynamometer.

E. E. F.

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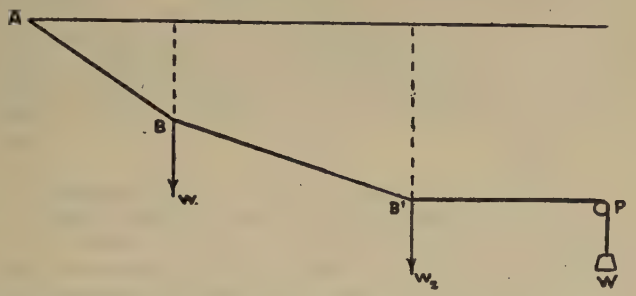
937. *Induction Coils.* **H. Armagnat.** (Écl. Électr. 15. pp. 52–62, 1898.)—This paper gives a full discussion of the theory of induction-coils, including equations and curves. C. K. F.

938. *Mechanical Calculator of Fall of Potential.* **W. H. Browne.** (Elect. World, 31. pp. 610–612, 1898).—The device is illustrated in the accompanying diagram. One end of a cord is



fixed at A, while the other passes over a pulley and carries a weight W. The pulley P is movable in a vertical direction (being attached to rollers running on guides). Attached to various points B, B in the cord are weights W_1, W_2. The position of P is adjusted until the last section B'P of the cord is horizontal. A represents the feeding-point of a distributor. Abscissæ measured horizontally to the right of A correspond to distances along the main; the weights W_1, W_2 represent currents tapped off at the corresponding points, while the ordinates of these points (measured vertically downwards) represent the fall of potential from the feeding-point. The tension W of the cord corresponds to the sectional area of the main. By affixing a properly divided scale to the board on which the apparatus is mounted, the arrangement may be made direct-reading. It is obvious that various problems on the fall of potential along a distributor may be readily solved by means of this apparatus. A. H.

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939. *Temperature Variations of Clark Cells.* **F. S. Spiers, F. Twyman,** and **W. L. Waters.** (Phil. Mag. 45. pp. 285–298, 1898.)—Similar experiments on the Board of Trade form of Clark cell were described by Prof. Ayrton and Mr. W. R. Cooper in the Proc. Roy. Soc. Dec. 1895. This paper is a completion of their work. The cells, which were of the Kahle type, were subjected to cycles of temperature, and from the resulting temperature-E.M.F. curves the required lag of E.M.F. behind temperature was determined. A suitable thermostat which kept the temperature of the standard cell constant to 0°·01 C., and a specially designed heating and cooling bath, in which the temperature was uniform to 0°·02 C. for the cells under test, are fully described. The E.M.F.s of the standard cell and that being tested were compared by a convenient and very sensitive modification of the potentiometer method. The standard E.M.F. was measured absolutely, correct to 0·0001 volt. At a rate of change of

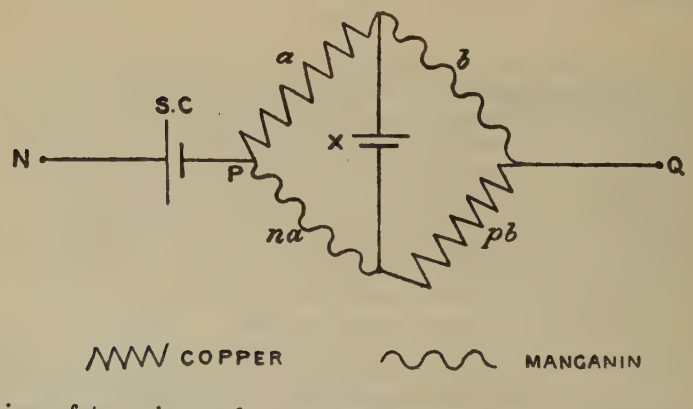
temperature of 1° C. in 7 mins., the lag of E.M.F. was 4 ten-thousandths of a volt, at 1° in 15 mins. it was $2\frac{1}{2}$ ten-thousandths, and at 1° in 30 mins. 1 twenty-thousandth. These lags are less than a quarter of those in the Board of Trade form. Experiments on the internal temperatures of the cells showed that about a half the above lags was due to temperature lag, and the rest to "diffusion" lag. Two Muirhead cells were also tested; they were somewhat inferior to the H-form as regards lag. The relative values of various types of Clark cells are discussed. Specimen curves are given. AUTHORS.

940. *Permanency of Clark Cells.* **W. R. Cooper.** (Electrician, 40. p. 748, 1898.)—The author gives the result of tests extending over $3\frac{1}{2}$ years. Cells set up in accordance with the Board of Trade specification were initially accurate to one part in 7000, but at the end of $3\frac{1}{2}$ years they showed a mean error of one in 700. Some cells showed a mean error of one in 500 after $2\frac{3}{4}$ years, the results in all cases being low. AUTHOR.

941. *Standard Cells.* **D. McIntosh.** (Journ. Phys. Chem. 2. pp. 185–193, 1898.)—The author has studied a number of cells in order to test their suitability as standards. Some good results were obtained, but no figures are given as to permanency. The cells include the Gouy cell, the $Zn—ZnCl_2—Hg_2Cl_2—Hg$ cell, the $Zn—ZnCl_2—PbCl_2—Pb$ cell, various cells having HgO as depolariser, the $Cu—CuSO_4—Hg_2SO_4—Hg$ cell, and the $Pb—PbCl_2—HgCl_2—Hg$ cell. The last but one gave good results. W. R. C.

942. *Temperature Compensators for Standard Cells.* **A. Campbell.** (Phil. Mag. 45. pp. 274–276, 1898.)—A description is

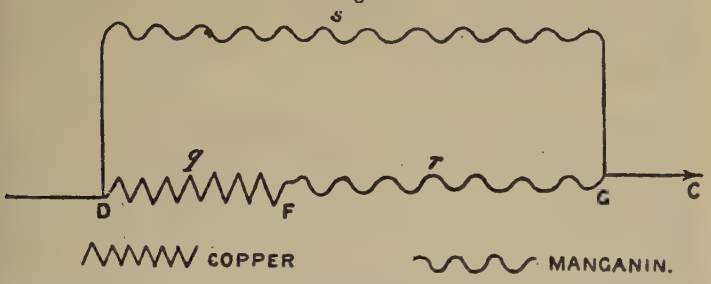
Fig. 1.



given of two pieces of apparatus for applying the temperature correction to standard cells. The theory has already been given

('Electrician,' pp. 601–603, September 1895). In the first arrangement the compensator adds or subtracts the proper small voltage in the manner shown in fig. 1. S.C. is the Clark cell, and X a Leclanché cell. The resistances a, na, b, nb had the values 48·66, 482·7, 63·63, and 495·0 ohms respectively. The whole combination when tested at various temperatures was found to give 1·400 volts to an accuracy of 1 in 2000. The second arrangement is shown in fig, 2, in which $r=s=2q=3·6335$ ohms. When

Fig. 2.



the current C is exactly 1·000 ampere, a Clark cell at any ordinary temperature will balance the voltage from F to G: thus a standard of current is obtained. AUTHOR.

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943. *Cadmium Cells.* **W. Jaeger.** (Ann. Phys. Chem. 65. 1. pp. 106–110, 1898.)—The E.M.F. of one cadmium amalgam with respect to another varies very slightly with the concentration as long as the percentage of cadmium is kept below 15. Above that value, not only does the variation in E.M.F. attain several millivolts, but it takes several days to settle down to its final value. The E.M.F. of pure cadmium with respect to a 14·3 per cent. amalgam is 0·051 volt, whereas that of zinc with respect to zinc amalgam is negligible. This constitutes an advantage of the Clark cell over the cadmium cell. But as long as the cadmium amalgam used contains under 10 per cent. of cadmium, the errors likely to be introduced are not serious. E. E. F.

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944. *Thomson Effect in a Binary Electrolyte.* **F. G. Donnan.** (Phil. Mag. 45. pp. 529–532, 1898.)—The *Ludwig-Soret* phenomenon, *i. e.* the production of concentration-changes in an unequally heated solution, has been explained by van't Hoff as due to differences of osmotic pressure. In the present paper a formula is obtained, on the basis of this theory, for the Thomson coefficient σ. The result is

$$\sigma=\frac{R}{\omega\epsilon}(1-2n)\left(1+\frac{t}{a}\frac{da}{dt}\right),$$

where R=gas-constant, ω=valency, ϵ=quantity of electricity

associated with a monovalent gram-ion, and α = degree of electrolytic dissociation. It is shown from this that the *Thomson Effect* in aqueous salt-solutions would not usually amount to more than a few thousandths of a volt at most. AUTHOR.

945. *Hall Effect in Liquids.* **F. Chiavassa.** (L'Elettricista, 6. p. 10, 1897.)—The author repeated as nearly as he could Bergard's experiments, which were alleged to have established the presence of a true Hall effect on liquids. He obtained indications of a cross-current, but attributes it to differences of temperature and concentration, due to the want of uniformity of the magnetic field. A small liquid film exposed in a uniform field gives no indications of a Hall effect. E. E. F.

946. *Oscillatory Currents.* **E. F. Northrup.** (Elect. World, 31. pp. 524–526, 584–585, & 607–610, 1898.)—This is a series of articles dealing with the phenomena of high-frequency currents. The writer begins by giving a simple non-mathematical account of the way in which a combination of an inductance and a capacity may be made to produce rapidly oscillating currents. Then follows a detailed account of the various methods of arranging a circuit for the production of high-frequency currents when the source of E.M.F. is an influence machine, an induction-coil, a continuous-current dynamo, or an alternator. Full directions are next given, with dimensional drawings, for the construction of a high-potential transformer, a condenser, and a high-frequency transformer, the apparatus being suitable for X-ray work on a 104- or 52-volt circuit at a frequency of 125. A. H.

947. *Measurement of Phase-Difference.* **H. Martienssen.** (Zeitschr. Elektrotechn. Wien, 16. pp. 93–96, 108–109, & 117–119, 1898.)—Two methods are described. In the first, a Joubert contact-maker in the circuit of a galvanometer connects it periodically across a non-inductive resistance included in each of the two circuits under test. The position of the contact-brush corresponding to zero value of the current is ascertained for each circuit, and thus the phase-difference determined. The second method involves the use of a phase-meter consisting of 3 coils. Two of these are wound side by side on the same bobbin, while the third is placed at right angles to them. In the central space is suspended a hollow sphere of pure silver. The currents are sent through two of the coils which are at right angles to each other. The circuit of the remaining or secondary coil is closed through a non-inductive resistance. The author shows that if M stand for the mutual inductance of the co-planar coils, and r for the total resistance of the secondary circuit, then, assuming r to have been adjusted until there is no deflection of the silver shell (indicating the absence of a *rotating* field), the angle of phase-difference is approximately $\phi = \tan^{-1}(p\mathrm{M}/r)$, this result being correct within $\frac{1}{2}$ per cent. so long as $p\mathrm{L}/r < \cdot 03$, L being the self-inductance of the secondary

coil. By this method it is possible to measure values of ϕ up to the limit determined by the maximum value of M/r. For larger values, an auxiliary coreless induction-coil may be used, whose primary and secondary are connected respectively in series with those of the phase-meter. The new value of M must, of course, in this case be determined. Examples of measurements by both methods are given. A. H.

948. *Effects of Heating on Magnetic Properties of Iron.* **S. R. Roget.** (Roy. Soc. Proc. 63. pp. 258–267, and Electrician, 41. pp. 182–184, 1898.)—The paper contains some results of a series of experiments on the change of hysteresis in soft iron transformer-plate, due to continued heating for various different temperatures. The specimens, initially in the annealed state, were heated in small ovens, and removed periodically to be tested in Prof. Ewing's hysteresis-tester at atmospheric temperature. Below 40° C. no evidence was found of any change. Between 40° C. and 135° C. the hysteresis increased with time, at first rapidly, and slower later. At higher temperatures the value of the hysteresis reaches a maximum, and then decreases; for example, at 160° C. the hysteresis doubled in a few hours and nearly trebled in a few days, afterwards falling. Beyond about 180° C. the hysteresis, although rising more rapidly at first, does not reach so high a maximum value and begins to fall sooner and faster, tending apparently to a lower steady state the higher the temperature. For example, at 260° C. the maximum was already passed in 15 minutes, a steady state only 50 % above the original hysteresis being reached in about 15 days. In all cases the original state was restored by reannealing. Ballistic curves are also given for a ring of similar material, before and after heating. AUTHOR.

949. *Magnetic Susceptibility of Water.* **H. du Bois.** (Annal. Phys. Chem. 65. 1. pp. 38–40, 1898.)—The author points out that he had forestalled Jaeger and Meyer in indicating the temperature-coefficient of the susceptibility of pure water. As regards their discovery that the atomic magnetisms of Ni, Co, Fe, and Mn are in the ratio 2:4:5:6, his own experiments, as far as they go, tend to confirm it (see Abstract No. 161). E. E. F.

950. *Magnetic After-Effect.* **C. Fromme.** (Annal. Phys. Chem. 65. 1. pp. 41–71, 1898.)—The experiments are limited to the effect observed after a diminution of the magnetising force. When that is reduced to a value above zero, the slow change of magnetisation is termed the after-effect of the temporary moment. When the force is reduced to zero, the effect observed is called the after-effect of the permanent moment. The latter does not depend in any way upon the duration of the magnetising influence. But it decreases when the reduction to zero is accomplished very rapidly; and, conversely, it increases when the reduction is accomplished

gradually, or through several intermediate stages. Heating the wire accelerates the after-effect of the permanent moment, without affecting its value; but repeated bending diminishes it as well. This is explained on the molecular hypothesis by supposing that local tensions are broken up by heating and bending, and so allow the magnetic effects more free play. E. E. F.

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951. *Magnetisation and Conductivity.* **G. Milani.** (N. Cimento, 4. 6. pp. 191–197, 1897.)—Experiments made by Neesen in 1884 indicate that magnetisation exercises a slight influence upon the electric conductivity of a solution of ferric chloride when the tube containing it is parallel to the magnetic lines of force. A series of careful experiments made by the author with strong magnetic fields show that this effect does not exist, or is too slight for detection. E. E. F.

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952. *Magnetic Deformation of Nickel.* **E. T. Jones.** (Roy. Soc. Proc. 63. pp. 44–54, 1898.)—An account is given of experiments which are a continuation of those described by the author in Phil. Trans. 189. (1897) p. 189, which consisted of measurements of the magnetic contraction of a nickel wire and a comparison of these with the values deduced from Kirchhoff's theory. The observed contraction of nickel was much greater than the calculated value. From the repetition and extension of the experiments here described on the effect of temperature on the magnetic contraction, it appears that at low fields (up to 90 C.G.S.) a rise of temperature of 35° C. caused an increase, at higher fields a diminution of contraction; and if the temperature was then lowered, the contraction returned to its former value. Observations were made on change of length and corresponding field-strength. Measurements were next made of the magnetisation, and the effect of change of tension on the magnetisation. The most important term in the calculated value of the elongation of a long wire of soft magnetic metal is represented by $\frac{1}{2}H(\delta I/\delta P)$, where H is the magnetising field and δI the increase of magnetisation produced by a small increase of longitudinal tension δP per unit area. The experiments indicate a slow time-change in the magnetic behaviour of the nickel wire. The effect of this change on $\delta I/\delta P$ is very marked at low fields, though slight at higher fields; $\delta I/\delta P$ appears to diminish rapidly at low fields, as time goes on. This is remarkable, as the magnetic contraction at low fields seemed to change but slowly with time, and more rapidly at higher fields. Some of the results are shown graphically, and all are recorded in tables showing the corresponding changes in the quantities observed. J. J. S.

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953. *Cycles of Magnetic Torsion.* **G. Moureau.** (Comptes Rendus, 126. pp. 463–466, 1898.)—When an iron wire is subjected to a torsional cycle, the magnetic torsion also goes through

a cycle. That torsion for which the magnetic torsion is zero is termed the residual torsion. It is the same for all magnetic fields, and offers a well-marked criterion of the magnetic properties of a substance. The residual torsion is inversely proportional to the thickness of the wire. For a diameter and length of 1 cm., this torsion is 0·00067 of the circumference. When a certain torsion is reached, the generators of the cylindrical wire are torn, and the wire does not return to its original state.

E. E. F.

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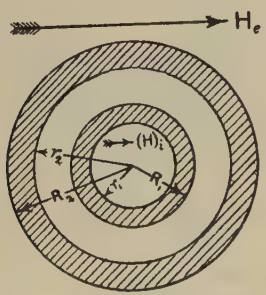
954. *Magnetic Shielding.* **H. du Bois.** (Electrician, 39. 1897, and 40. pp. 814–817, 1898.)—In this elaborate series of articles, the shielding-effect of spherical and cylindrical sheaths is fully considered. Details of calculation are in most cases omitted, the method used in arriving at certain results being merely outlined.

Theory of Spherical and Cylindrical Bi-lamellar Sheaths.—It is assumed that the sheath is of homogeneous isotropic material, and that its permeability is constant. It is placed in a uniform field of intensity $\mathbf{H}_e$, and the problem is to express the ratio (called by the author the "field-ratio") $g = \mathbf{H}_e/(\mathbf{H})_i$, where $(\mathbf{H})_i$ denotes the field inside the sheath, in terms of the permeability μ and the geometrical data of the sheath. Starting from the well-known expressions ($-\frac{4}{3}\pi\mathbf{I}$ and $-2\pi\mathbf{I}$) for the demagnetising intensities inside a solid uniformly-magnetised sphere and cylinder (axis normal to field) respectively, the author points out that similar expressions, but with sign reversed, hold for the case of spherical or cylindrical air-cavities hollowed out of an infinitely extended uniformly magnetised medium.

From these results are deduced expressions for the normal components of **B** at points on a spherical or cylindrical surface

Fig. 1.



lying either inside or outside the surface of separation of the two media. If now a bi-lamellar sheath, such as the one shown in section in fig. 1, be considered, there will be four boundaries

separating the non-magnetic from the magnetic material. Corresponding to each boundary an equation may be written down expressing the continuity of the normal induction on each side of the boundary. From these four equations, after elimination of the quantities not required, the author arrives at the following expressions for the "field-ratio" g:—

$$g-1=\frac{2}{9}\frac{(\mu-1)^2}{\mu}\left\{(1-p_1p_2)+\frac{2\mu^2+5\mu+2}{9\mu}m_{12}m_1m_2\right\} . \quad \text{(I.)}$$

for a spherical bi-lamellar, and

$$g-1=\frac{1}{4}\frac{(\mu-1)^2}{\mu}\left\{(1-q_1q_2)+\frac{(\mu+1)^2}{4\mu}n_{12}n_1n_2\right\} . \quad \text{(II.)}$$

for a cylindrical bi-lamellar; where (see fig. 1)

$$\begin{array}{lll} p_1=r_1^3/R_1^3; & p_2=r_2^3/R_2^3; & p_{12}=R_1^3/r_2^3; \\ m_1=1-p_1; & m_2=1-p_2; & m_{12}=1-p_{12}. \\ q_1=r_1^2/R_1^2; & q_2=r_2^2/R_2^2; & q_{12}=R_1^2/r_2^2; \\ n_1=1-q_1; & n_2=1-q_2; & n_{12}=1-q_{12}. \end{array}$$

Discussion of Theoretical Equations.—In order to compare the shielding effect due to a bi-lamellar with that of a single thick shell of the same dimensions, we may suppose that R_1 becomes equal to r_2; *i. e.*, that the interferric air-shell vanishes. We then get

$$g'-1=\frac{2}{9}\frac{(\mu-1)^2}{\mu}(1-p') \quad \text{for a spherical shell,}$$

and

$$g'-1=\frac{1}{4}\frac{(\mu-1)^2}{\mu}(1-q') \quad \text{for a cylindrical shell,}$$

where

$$p'=r_1^3/R_2^3 \quad \text{and} \quad q'=r_1^2/R_2^2.$$

From this it is at once seen that $g'<g$; an advantage is therefore secured by the use of an interferric space between the two shells. The formulæ may be simplified by supposing (1) that μ is large (>100), and (2) that the thickness d of each shell is small in comparison with its radius. The formulæ then become

$$g-1=\frac{2}{9}(\mu-2)\left\{\frac{3d_1}{R_1}+\frac{3d_2}{R_2}+2\left(\mu+\frac{5}{2}\right)m_{12}\frac{d_1}{R_1}\cdot\frac{d_2}{R_2}\right\}$$

for a thin spherical bi-lamellar, and

$$g-1=\frac{1}{4}(\mu-2)\left\{\frac{2d_1}{R_1}+\frac{2d_2}{R_2}+(\mu+2)n_{12}\frac{d_1}{R_1}\cdot\frac{d_2}{R_2}\right\}$$

for a thin cylindrical bi-lamellar.

For thin uni-lamellars, we get

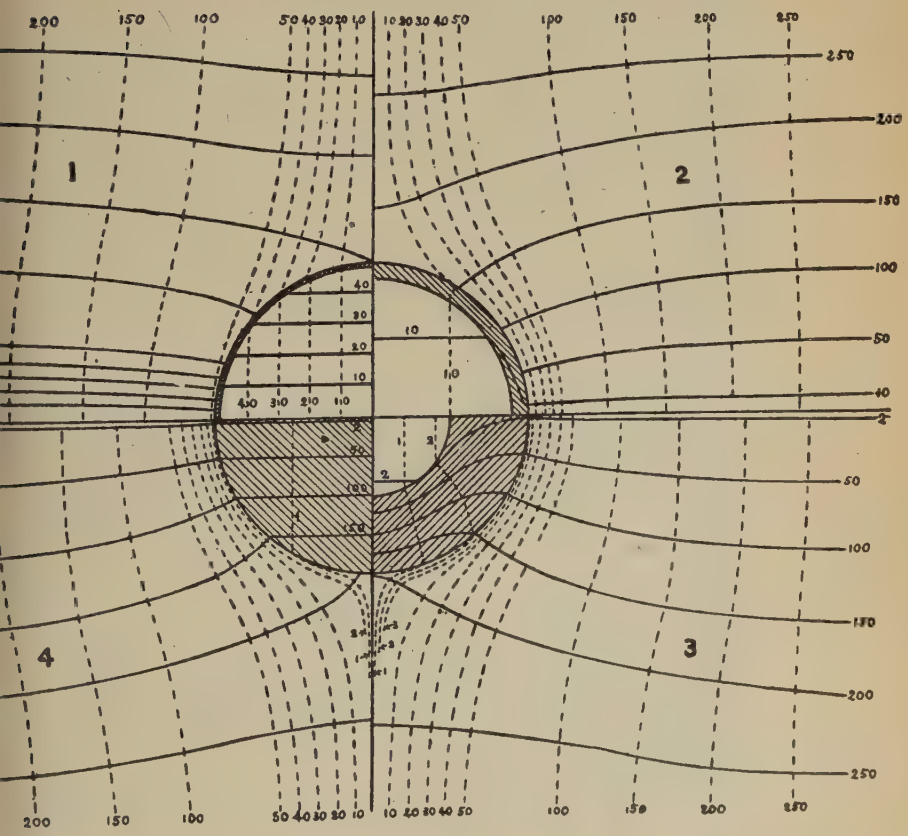
$$g-1=\frac{2}{3}\frac{d}{R}(\mu-2)\doteqdot\frac{8\pi\kappa}{3}\frac{d}{R}\quad\text{(sphere)},$$

and

$$g-1=\frac{1}{2}\frac{d}{R}(\mu-2)\doteqdot 2\pi\kappa\frac{d}{R}\quad\text{(cylinder)}.$$

Corollaries of Theoretical Equations.—The last set of equations suggests a simple method of measuring the *initial permeability* or susceptibility of iron sheet or wire. For if the value of g be determined by any suitable method, the equations enable us to find the corresponding value of μ or κ.—The relation between the shielding effect and weight of shell is next discussed. It appears that with uni-lamellars the shielding effect is, for small thicknesses of the shell, nearly proportional to the thickness; but beyond a

Fig. 2.



certain limit (a thickness $=10\,\%$ of mean radius for spheres, and $15\,\%$ for cylinders) very little is to be gained by further increasing the thickness. Beyond this limit it is better to subdivide the shield, making it bi-lamellar. For the latter, the condition of minimum weight is approximately satisfied by making $r_2/R_1 = 1{\cdot}3$ to $1{\cdot}4$ for spheres and $1{\cdot}5$ to $1{\cdot}6$ for cylinders.

Graphical Representation.—Fig. 2 (p. 499) is a diagram showing the shielding effect in an originally uniform field due to (1) a very thin cylinder ($r/R = {\cdot}98$), (2) a somewhat thicker cylinder ($r/R = {\cdot}92$), (3) a cylinder of considerable thickness ($r/R = {\cdot}5$), (4) a solid cylinder. The permeability is taken as 102. The full lines are lines of magnetic induction, the dotted ones being equipotentials. It will be seen that in the case of the thin cylinder the lines enter the *outer* surface of the shell obliquely, and that as the thickness increases the angle of incidence approaches a right angle. At the *inner* surface, on account of the fact that the field inside the shell must be uniform, the lines are not in general normal to the surface. The lines are numbered, so that their course may be easily traced. An iron-filings picture confirming the theoretical diagram of fig. 2 is also given by the author.

Internal and External Shielding.—In the preceding discussion the shielding has been *internal*—*i. e.* the object of the shield has been to protect the space inside it against external disturbance; but cases may arise in which a shield is used for the protection of external space against magnetic disturbances going on within the shield. Such cases may be referred to as *external shielding*. This is not always possible; *e. g.*, in the case of a *single* magnetic pole contained within the sheath, or a linear current along its axis, no shielding effect takes place. But with a circular current, or two poles within the sheath, shielding is effective. It may be shown, by several methods, that for a given sheath the internal and external shielding ratios (g) are equal.

Experimental Investigation.—Some preliminary experiments are described in which the shielding effect was determined by the method of oscillations. This not proving satisfactory, except for rough measurements, the method of deflections was resorted to. The results obtained are in as good agreement with theory as might be expected. They also show that for moderate disturbing fields the shielding depends on the constant initial permeability for small increments or decrements of force, the actual magnetisation of the sheath not affecting the result. This is clearly shown in one case, in which the sheath was circularly magnetised by a coil of wire without the occurrence of any perceptible change in its shielding effect. Another experiment shows that when the length of a cylindrical sheath is three or four times its radius, the shielding in the central portion is practically the same as that due to the infinitely long cylinder considered in the theoretical part of the investigation.

Permeability Tests.—The formulæ developed in the earlier part of the paper are applied to the determination of the initial

permeability by means of a "shield permeameter" (which is fully illustrated and described), the method of deflections being used. Values of the initial permeability ranging from 100 to 234 are obtained by this method.

Applications of Shielding.—In most practical cases, bi-lamellar sheaths will afford sufficient protection. If three sheaths are used, it is probably best to make the thickness of each about equal, and not more than, 10 % of its mean radius, and to make the clear width of each of the two air-spaces about 30 % of its mean radius.

Dynamical Shielding.—In this section the effect of magnetic shielding on the dynamical stresses existing between the impressed field and any part of an electromagnetic system is discussed. It is shown, from the principle of the conservation of energy, that the "field-ratio" has the same value for a given shield, whether the shielding be internal or external.

Current Shielding.—The particular case of a straight axial current shielded by a concentric cylinder is considered in detail. An experiment is described which shows that with a cylindrical sheath of transformer-iron 4 cms. in diam. and only ·039 cm. thick, as much as 93 % of the dynamical force is transferred to the shield. Thicker shields would take up practically the whole of the force. Reproductions are given of filings-pictures obtained with (*a*) a straight unshielded conductor in a uniform field, (*b*) a similar conductor surrounded by a cylindrical sheath.

Induced E.M.F. in Shielded Conductors.—The fact that when a shielded conductor moves (with its shield) across a uniform field, the E.M.F. induced in it is identical with that of an unshielded conductor (although in the former case the conductor is always in a very much weaker field), is best explained by considering *tubes* of induction rather than lines of force. The velocity with which the axis of the conductor crosses the tubes must be proportional to their section if the magnetic configuration is to remain unaltered during motion. Hence the induced E.M.F. is not affected by shielding.

The paper concludes with a discussion of some filings-pictures which show very clearly how the tangential drag on a dynamo armature is produced by current-carrying conductors embedded in slots of various shapes in the core. A. H

ELECTRO-CHEMISTRY AND CHEMICAL PHYSICS.

955. *Determination of Molecular Weights of Gases from their Densities.* **D. Berthelot.** (Comptes Rendus, 126. pp. 954–956, 1898.)—Since gases obey the laws of Boyle and Charles more closely as the pressure is diminished, the author assumes that at infinitely small pressures they would obey these laws exactly, and therefore all gases would have exactly the same molecular volume. Calling v the volume of a quantity of gas at infinitely small pressure p, and v_0 its volume at atmospheric pressure p_0,

$$\frac{p_0 v_0}{pv} - 1 = a(p - p_0),$$

where a is constant for moderate pressures and is assumed to remain so down to pressure p. From this equation

$$v_0 = vp/p_0(1 + ap - ap_0).$$

Taking quantities of two different gases which occupy equal volumes at infinitely small pressure (that is, by hypothesis, equal molecular quantities), we find the ratio of their volumes at atmospheric pressure to be

$$v_0/v_0' = (1 - ap_0)/(1 - a'p_0).$$

The product of the molecular volume thus found and the density is obviously proportional to the molecular weight of the gas, which is thus obtained from the density and compressibility of the gas at the ordinary temperature. The following molecular weights are calculated from the determinations of Leduc:—Hydrogen 2·01472, nitrogen 28·0132, carbonic oxide 28·0068, oxygen being taken as 32. T. E.

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956. *Explosion of Mixtures of Methane and Air by Electric Spark.* **H. Couriot** and **J. Meunier.** (Comptes Rendus, 126. pp. 901–904 & 1134–1136, 1898.)—A wire may be raised to incandescence and fused in a mixture of air and methane containing 9·5 % of the latter, without causing explosion; the spark which occurs when the wire breaks produces the explosion. Using an E.M.F. of 110 volts, the spark fails to produce an explosion if a shunt is attached to the terminals of the wire passing through the explosion vessel, provided that the shunt has nearly the same resistance as the wire. When the resistance of the shunt is much larger or much smaller than that of the wire, explosion is produced by the spark. If the wire is coiled up so as to possess more or less self-induction, the spark brings about the explosion more readily; by diminishing the E.M.F. employed, however, the explosion is again prevented. T. E.

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957. *Eutectic Alloys.* **G. Charpy.** (Journ. de Physique, 7. pp. 145–151, 1898.)—Alloys of tin and bismuth are examined in the way described by the author previously (Comptes Rendus, 1897, 124. pp. 957–959). Microphotographs of etched sections of the eutectic alloy and of alloys containing excess of one or other constituent are given. The analogous structure of a silver-antimony alloy and of steel is pointed out. T. E.

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958. *Osmotic Pressure.* **J. Larmor.** (Cambridge Phil. Soc. Proc. 9. pp. 240–242, 1897.)—The author considers that the thermodynamic basis of the law of osmotic pressure is valid. The hypothesis of ionic dissociation must be judged separately by its agreement with the facts. The author takes the view that each molecule of a dissolved substance sensibly influences the molecules around it up to a certain minute distance, so as to form a loosely connected complex. So long as the solution is so dilute that each of these complexes is for the greater part of the time out of range of the influence of the other complexes, the principles of thermodynamics necessitate the osmotic law. This is so, whether the nucleus of the complex is a single molecule, a group of molecules, or an ion; the pressure merely depends on the number of complexes per unit volume. To determine the osmotic forces, the change of available energy involved in diluting the solution is needed. To find this, the laws of the mutual action between the molecules of the dissolved substance are not required, because there is no such action. In concentrated solutions where such action exists the theory does not hold. The laws of the mutual action between the dissolved substances and the solvent are also not required to be known, because the addition of more solvent to the solution does not in any way alter the individual complexes. The effect of dilution is merely to scatter these through a larger volume, and the change of available energy is due to this expansion in the same way as in the expansion of a gas. T. E.

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959. *Electrolysis of Water.* **P. Garuti.** (Elettricità, Milan, 17. pp. 152–153, 1898.)—The chief difficulty in the preparation of hydrogen and oxygen by electrolysis of water lies in the complete separation of the gases with due regard to economy. Attempts in this direction have hitherto only been made with the aid of non-permeable diaphragms between the electrodes; but owing to the great resistance thus offered to the current, and to practical difficulties, such methods have no commercial value. The use of metallic diaphragms has been considered impossible, it being supposed that they must necessarily take part in the electrolysis, hydrogen being evolved at the face opposite the anode, and oxygen at that opposite the kathode; and this is indeed the case if the electrodes are completely separated by the diaphragm, the use of which merely converts the one cell into two. But if the electrodes

are not completely separated, and sufficient space is provided below the diaphragm to allow of the passage of liquid from one electrode to another, the element behaves as a simple cell. This is the principle of the author's process, a more detailed description of which is reserved; a plant of 32 cells, however, yielding daily 30 cubic metres of oxygen and 60 of hydrogen, has been working for six months at Tivoli, and the gases are sufficiently pure for industrial purposes, the oxygen containing about 1·5 % of hydrogen, and the hydrogen only a trace of oxygen. J. W.

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960. *Cowper-Coles Gold-Recovery Process.* **S. Cowper-Coles.** (Elect. Rev. 42. pp. 779-780, 1898.)—The principal feature of the Cowper-Coles process for the Recovery of Gold from Cyanide solutions is the use of an aluminium kathode, which overcomes one of the chief difficulties appertaining to the economical recovery of gold from weak cyanide solutions by electrolysis. In the Siemens-Halske process lead foil or lead strips are used, the cutting up of which is a tedious matter. If several sheets are cut superimposed, the strips cling together, and have to be carefully spread out one by one, so that the surface may be exposed to the solution. A clean up is made every 7 to 8 weeks, when the wood frames carrying the lead strips are withdrawn, the lead strips removed and new substituted, the auriferous lead being ultimately melted down and conveyed to a central works to be cupelled. This method is both crude and expensive, the labour of fitting the strips into the frames is considerable, and the consumption of lead is a large item, having been computed by Von Gernet at the Worcester Mine at 1·10 of a penny per ton of ore treated. The author overcomes these difficulties by substituting aluminium plates for the lead-foil, advantage being taken of the fact that a loose oxide is formed on the surface of the aluminium which enables the deposited gold to be readily stripped or wiped from the kathodes as pure gold. Gold by this process has been successfully extracted from cyanide solutions containing only ·01 per cent. of potassium, 2½ dwts. of gold to the ton of solution. The substitution of aluminium for lead foil or strip, enables the gold to be obtained as pure gold, and also daily returns to be made of the amount of gold recovered; it has also the additional advantage of reducing the cost of labour, and economising the amount of cyanide of potassium used, as the solution is not contaminated by any base metals, such as zinc, as in the MacArthur Forrest process. AUTHOR.

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961. *Electrolytic Production of Aluminium at Foyers.* **R. W. Wallace.** (Soc. Chem. Ind. Journ. 17. pp. 308–314, 1898.)—A high-level tunnel leads the water from above the Falls of Foyers to six lines of cast-iron pipes communicating with the turbines, which, with the factory, are on low-lying land near Loch Ness. In order to equalise the flow of water, a dam has been built above

the Falls, uniting two small lochs into a reservoir capable of holding about 4,000,000,000 gallons, at a height of about 700 ft. above Loch Ness. Penstocks are provided in the dam, so that the water from the reservoir may be utilised to any desired extent when the water draining from the hills is insufficient. At present there are in use 5 large turbines and dynamos, each of about 700 E.H.P., and two others of equal size are in course of erection. The dynamo and turbine rotate on the same shaft at 150 revs. per min., and each dynamo gives 8000 amps., at a cost of less than one third of what it would be if generated by coal and steam-power. The Héroult process is used, alumina being charged into the fused cryolite constantly as aluminium is deposited; the temperature of the electrolyte is between 750° and 850°, to maintain which (added to the absorption of energy in decomposing the Al_2O_3) an E.M.F. of from 3 to 5 volts is required, of which theoretically 2·8 volts are used in electrolytic action. About 8000 amp. per cell are employed, which is equivalent to C.D. of 700 amp. per sq. ft. of kathode-surface, and 35 amp. per sq. in. of anode area. The practical yield of metal is 1 lb. per 12 E.H.P. hrs. Pure alumina is used, and the carbons are specially prepared by the Company, so that they shall not disintegrate under the high current density employed, and form short circuits; and so that they shall not introduce impurities into the bath. Theoretically, the weight of carbon used up should bear to that of aluminium reduced the ratio 2 : 3, but in practice it is about 1 : 1.

In the discussion, in reply to Vautin's statement that pure Al_2O_3 could be made by a new process for from £3 to £4 per ton, it was elicited that the company's production of this material cost £12 per ton. It was also stated that the cost of power at Foyers was about 30*s.* per H.P. per ann., exclusive of interest on capital, as against £9, which was Prof. Kennedy's figure for steam-power in Scotland with coal at 3*s.* 6*d.* per ton. Finally, it was said that no fluorine was evolved during electrolysis, provided that the voltage did not exceed 3 to 5, the voltage theoretically required for decomposing aluminium fluoride being 4, and that for sodium fluoride 4·7 volts. W. G. M.

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962. *Castner-Kellner Alkali Works.* **J. B. C. Kershaw.** (Electricity N. Y. 14. pp. 293–294, 1898.)—In this article upon the Electrochemical Industries of England, the author gives some financial details concerning the Company owning the above works. The article opens with some remarks concerning the growth of industrial Electrochemistry in Europe during the period 1878–98, and then passes on to the history of the Company. The work of the first section of the plant (1000 H.P.) has been satisfactory, and the extension of the works to the originally designed capacity of 4000 H.P. is now being rapidly pushed forward. The company has arranged with the German "Solvay" Company to accept delivery of their total output of bleach at a fixed price for a period

of 3 years, and is thus ensured of a market for their chief product. The second 1000 H.P. installation is to be used for the production of caustic potash in place of caustic soda. The Mathieson Alkali Company of U.S.A. are working the same process at Niagara with 1500 H.P. from the Falls. AUTHOR.

963. *Treatment of Sulphide Ores containing Lead, Zinc, and Silver.* **O. J. Steinhart.** (Indus. & Iron, 24. pp. 262–263, 282–283, 1898.)—The author alludes to the treatment of these ores by the processes of Létrange, Lambotte and Doucet, Cassel and Kjellin, Siemens and Halske, Sinding-Larsen, Cowper-Coles, Herrmann, Nahnsen, Lindeman, Hoepfner, Bridgman, Hurter, United Alkali Co., Brewer, Emmens, Wilde Kynaston and Brock, Parker and Pullman, Ashcroft, Dieffenbach, Lorenz, Borchers, and others. W. G. M.

964. *Electrolytic Hypochlorite.* **A. Volta.** (Elettricità, Milan, 17. pp. 312–314, 1898.)—In Tailfer's process for the electrolytic production of sodium hypochlorite, the electrolysis is effected in a vessel divided into two concentric departments by a diaphragm of asbestos, the inner compartment containing the kathodes of gas carbon, the outer, iron anodes. The chlorine and soda produced by the electrolysis of the salt solution are conducted to a special absorbing vessel, where the hypochlorite is formed by their admixture, which thus takes place *outside* the electrolytic cell. This is the special feature of the process. The product thus obtained has a strength of 20°–35°, *i.e.*, contains 20–35 times its volume of available chlorine, whereas by the Hermite process the strength of the liquid is at most 1°·5–2°. The electrolyte employed contains 250 grams of sodium carbonate per litre; working with 100 amperes at 100 volts, 20 hours suffice to produce 800 litres of solution at 30° strength, equivalent to 400 kilogrammes of hypochlorite. The cost of production is said to be only one-third of the present market price of the hypochlorite. J. W.

GENERAL ELECTRICAL ENGINEERING.

965. *Fulmen Accumulator.* (Elect. Rev. 42. pp. 786–787, 1898.)—The essential characters of accumulators for motor-carriages are high specific power (watts per kilogram of weight) and high specific energy (watt-hours per kilogram of total weight), in order that the dead weight carried shall be as small and the length of journey as great as possible. In these respects the type of accumulator described (B_{13}) is considered to be superior to all others examined. There are 13 plates, 6 positive and 7 negative, which are 18·5 cm. high, 9·5 cm. wide, and 4 mm. thick; they consist of blocks of 24 rectangular cells, charged with the active material, and are prevented from touching by sheets of celluloid. These partitions, with the celluloid trough, weigh 600 grams, while the complete element with the liquid is 7·5 kilograms. The weights of the moist positive and negative plates are 475 and 390 grams respectively, the grid in each case being only 135 grams. The normal discharge is 21 amperes during 5 hours, the mean E.M.F. being 1·9 volts, and the capacity 105 ampere-hours. Each element supplies 40 available watts and contains energy equal to 200 watt-hours. The constants of the element per kilogram of total weight are: specific output, 3 amperes; available specific power, 5·3 watts; specific capacity, 14·6 ampere-hours; available specific energy, 26 watt-hours. The specific weight is 190 kilograms per kilowatt, or 37·5 kilograms per kilowatt-hour. J. W.

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966. *New Storage Battery.* (Elect. Rev. N.Y. 32. p. 268, 1898.)—This is a description of a high tension or "series" battery designed by N. H. Edgerton, and installed at Sonderton, Pa., U.S.A. The plates are 6 feet wide by 7 feet high, and are piled horizontally upon one another, each being positive on its upper and negative on its lower side. The upper or positive surface is covered with a thin layer of asbestos, and then a layer of pulverised oak-charcoal which keeps the plates apart and also acts as an absorbent for the electrolyte, so that no containing-vessel is needed for the battery. There are 110 plates forming a pile about 7 feet high and having a total weight of 16 tons. The open circuit E.M.F. of the battery is 225 volts and its capacity 300 ampere-hours. E. J. W.

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967. *Storage Battery Meter.* **W. S. Aldrich.** (Elect. Rev. N.Y. 32. p. 251, 1898.)—The Thomson meter, as modified for use with storage batteries, runs more slowly forward during charging than backward during discharging, the ratio of the speeds being adjusted to suit each case, so that the reading always represents the nett amount of energy available from the battery. For electric carriages and launches a meter of this kind is very necessary, to indicate the condition of the battery. A. H. A.

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968. *Electric Meter.* **W. D. Marks.** (Frank. Instit. Journ. 145. pp. 309–310, 1898.)—This meter, for the three-wire system, comprises two solenoids and cores placed above a self-starting pendulum actuated by the electric current. This pendulum, by means of a cam, raises a pawl on a ratchet-wheel to a uniform height each stroke. The solenoids, by means of their cores, alter the angular position of a pendant arch attached to their axis so as to allow the pawl to drop along the ratchet-wheel a number of teeth proportional to the current passing through the meter. Thus, at each stroke of the pendulum, the load in amperes passing to the consumer is measured, and the ampere-hours added up by means of the ratchet-wheel and a dial-register. A pointer and scale are also provided for indicating the current in amperes flowing at any time. A photograph of a 22-light meter, showing the working parts, is given in the original paper. C. K. F.

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969. *Lightning Arresters.* **A. H. Gibson.** (Elect. Rev. 42. pp. 762–763, 1898.)—The author describes the effect of lightning discharges upon a 3000-volt power transmission plant in South Africa. The arresters used consisted of copper wires supported on porcelain insulators, and shaped like the Thomson-Houston arresters, but without magnetic blow-outs; the arc is carried upwards by the heated air, increasing in length until it breaks. An arrester was fixed upon each line, with a separate earth-plate; the resistance between two earth-plates, each 5 ft. × 3 ft., and near together, was 20 ohms. The nature of the discharges is described, and most of them attributed to secondary effects rather than to the line itself being struck. Smooth-core drum armatures are peculiarly liable to damage, while armatures with slotted cores seldom suffer. A. H. A.

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970. *Electric Wiring Practice.* **F. Bathurst.** (Elect. Engin. 21. pp. 664–667, 1898.)—The problem, with which the author concerns himself, is how to best instal the conducting wires of electric light or power installations, upon the consumer's premises, with due regard to safety and convenience, and at the same time instal electric wiring work which shall be in all points as durable and satisfactory as the present standard of work for gas or water. The author points out that although the Central Electricity Supply Stations are supplying upwards of 300,000 H.P. of electrical energy, the number of incandescent electric lamps at present installed represent only about 1% of the total amount of the gas-lighting that is carried out in the cities and towns of England; and he argues that, looking to the steady and continued progress electrical applications are all the while making, the question of good or bad electric wiring has become a matter of great and increasing importance. In fact, the position of the art

of wiring is now dominating the progress of extended electrical application and affects the immediate prosperity and future of the whole electrical industry.

(*Conditions.*)—It is now becoming generally understood that when electric wires are imperfectly installed, the electricity escaping from them can, under suitable and only too liable conditions, set fire to their surroundings, causing fires which are insidious in their character and which usually destroy all evidence as to their origin. The principles which underlie effective construction are dealt with. Conducting wires, although designed to carry current proportionate to their sectional area, will carry any current that may be passed through them, becoming, perhaps, in so doing overheated, and setting fire to the insulating covering around them. Hence, with electric wiring the possibility must be faced of injury occurring to the wires from within themselves, a condition of service very different from that holding in gas practice. In comparing the electric wire and its insulating covering with a gas-pipe, it is shown that the copper conductor is equivalent to the orifice of the gas-pipe, whilst the frail insulating covering is to be compared with the coating material (usually iron) forming the gas-tube. From mechanical considerations, therefore, insulated electric wires installed without other protection, compare with a gas service furnished through *rubber* tubes. The author refers to experiments which prove that when the insulation is arranged in the form of a surrounding tube, instead of being placed directly upon the conductor, the heating troubles referred to above are satisfactorily met. Experiments are also shown as to the limitation and unreliability of "safety fuses" usually put in circuit with the conductors to protect them from becoming overheated, and how insulating covers in a tube form can, in great measure, be used *instead* of fuse protection. Comparison is also made with gas service, showing how electric wiring is at a disadvantage by the presence of moisture, as, although insulating materials will withstand "pressure" or "voltage" when in a perfectly dry state, they are valueless when mechanically damaged or affected by moisture; and also how the leakage-current may, without giving immediate indication, by gradual corrosion destroy both the insulating covering and the conducting wire itself.

In good electric wiring, therefore, certain electrical, chemical, and mechanical conditions have to be guarded against, in order to prevent possible injury, both from within and without the electric circuit. The term "circuit" as applied to electric-light wiring, implies the use of two distinct wires, usually laid close together, one used as the "lead" from, and the other for the "return" of the current to the point of generation; and, holding to the gas-pipe analogy, the construction involved can best be grasped by imagining it necessary to provide a second and supplementary system of piping which would act as an exhaust system for collecting the products of combustion, in order to return them to the gasometer.

(*Practice.*)—Although 10 years have elapsed since electricity supply from Central Stations was first undertaken, there is as yet no generally recognized system of electric wiring which is permanent and satisfactory, as is the "iron-piping" standard in gas practice. The author condemns the "wood-casing" method, hitherto so general, as only an intermediate stage in electric-wiring practice, and makes experiments showing how readily a fire results from "overheating" or "leakage" trouble, where the conductors with imperfect or damaged insulating covering are lying on damp wood. The weakness is virtually admitted from the fact that wood-casing work must never be concealed; that is, it is necessary to have the wires and fittings "readily accessible" for easy inspection or replacement. He shows that the boxing-in of wires and joints tends to the existence of slip-shod and shoddy work, which no method of testing can discover, and no one dare guarantee for durability. This fact is made use of at present by any unscrupulous wiring contractor, and is said to account for the immense difference to be seen in the tenders submitted for wiring work. The author points out that wood-casing work is now prohibited in Germany, and is practically obsolete in the U.S. of America, where enlarged spheres of electrical application have provided the necessary and extended experience. He also refers to the fact, that although the experience of our Fire Offices may so far be deemed satisfactory, their present attitude towards new methods of work is not encouraging and may in time re-act injuriously to themselves. The increasing necessity for *concealed* work and a standard of practice analogous to that holding for gas service, is creating demand for systems other than wood-casing. The author, however, maintains that insulated conductors protected with a light lead sheathing, or even if enclosed in an ordinary metal pipe, are not desirable or suited to high-class installation work, and advocates as a standard method the use of insulating pipes or conduits, which, until an insulating material can be produced which is as hard as iron, should, for the best class of work, be mechanically protected by an iron or steel covering. A system of armoured insulating conduits can be installed in a building in the same manner as an iron gas-pipe system, and provides all the requirements for perfect electrical service. An insulating tube system is the only one which complies with the "arc proof" conditions necessary and provides installation which is free from electrical fire risk. With its general adoption contractors would not have to submit to the ineffective and oftentimes annoying inspection on the part of the Fire Office authorities, for the fire "possibility" arising from ignorance or carelessness on the part of the workman is counteracted or checkmated by the use of such material. Experiments are shown to prove the advantages of lined metal pipes over ordinary metal pipes, in respect to smoothness of interior, "bending," easy "drawing-in," simplicity of erection, non-liability to internal "sweating," and "arc proof" resisting qualities, etc., and the author concludes by pointing

out that an insulating conduit system of wiring provides in the highest degree the cardinal points of good wiring, namely, safety, durability, convenience, accessibility, and ultimate economy.

AUTHOR.

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971. *Insulators.* **A. T. Bell.** (Elect. Rev. N.Y. 32. pp. 186–187, 1898.)—Small glass insulators do not puncture at 40,000 volts because they avoid it by surface leakage. Porcelain does not do this. Electrical defects in glass are no more discernible with the eye than in porcelain. Annealing only diminishes the brittleness of the glass body as a whole, so that when part is broken off by a stone the whole insulator "flies." The non-use of glass in England is due to the moisture of the air. *Multi-glaze* insulators are criticised by the assertion that glaze is known to be the weakest and most absorbent part of good table china. The six coats of glaze used increase the chances of trouble. Under a test, one of the petticoats of some *multi-glaze* insulators were broken and the whole soaked in salt water. They failed to withstand the same pressure as single-piece insulators similarly treated.

Dr. Perrine's statement is endorsed, viz., "Only that amount of glass should be present (in the porcelain) which will fill up the porosity of the dehydrated silicate of alumina"—thus avoiding the brittleness of glass. The appearance of the fracture will detect glassy paste. Insulators should be tested before they are glazed and retested after the second fire in the glost kiln, at 25,000 to 100,000 volts. M. O'G.

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972. *Insulators for High-Tension Lines.* (Électricien, 15. pp. 212–219, 1898.)—The paper is a description with scale-drawings of new types of insulators for overhead lines capable of sustaining pressures up to 10,000 volts. They are manufactured by Burns et C^ie^, Paris. The insulator for 2000 volts has one internal petticoat only, but the outer surface of this has four ribs or what may be termed horizontal petticoats; this insulator, 8 cm. high and 9 cm. in diameter, presents a length of insulating surface of 26 cm. The insulator for 10,000 volts has two internal petticoats, the outer one quite short and the inner provided with two horizontal petticoats; the upper of these nearly touches the outer petticoat and the lower passing below it nearly touches the inner surface of the insulator bell. This arrangement produces three nearly closed annular chambers, into which it is difficult for moisture or dust to penetrate. The larger size, 9 cm. high by 115 cm. in diameter, has an insulating surface 30 cm. long. A heavy type is made for withstanding side pulls up to 400 pounds. For lower pressures, to take heavy pulls up to 600 pounds, as at angles or at the ends of lines, the insulator is held by a vertical bolt passing through it and fixed to an iron fork; above and below the central groove for the wire is a double petticoat. A high-tension line switch is constructed as follows:—An iron rod

is fixed to a cross-piece on the pole, its ends passing through caps cemented on to the tops of two insulators; pins cemented into these insulators terminate below in spring contacts, and contact is made by a metal bar provided with insulating handle. This bar is prevented from slipping out of the contacts by a copper wire passing through contact piece and bar, and fine enough to break easily in pulling down the bar. This bar is also made to take a fuse. G. H. Ba.

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973. *Submarine Boat 'Argonaute.'* **G. Dary.** (Électricien, 15. pp. 209–212, 1898.)—The object of this boat, built by S. Lake, Baltimore, is to facilitate the work of divers on sunken ships. When floating on the surface of the water it is propelled by a screw; when sunk to the bottom of the sea, it rests on three large wheels, a pair of which can be driven by a motor. In shape it is like an ordinary cigar-shaped boat, 11 metres long, 2·75 metres diameter. The hull is capable of resisting a pressure of 5 or 6 atmospheres, so that it can sink to a depth of 50 metres. The hull is divided into 4 compartments, in the largest of which the motors and crew are placed. The divers ready for work enter a second compartment, usually at the same air-pressure as the first, but in which the air-pressure is raised by pumps until it is equal to the exterior pressure. The divers then enter a third compartment, which by an opening at the bottom of a small ladder, gives access to the bottom of the sea. The fourth compartment at the bow contains a powerful search-light. Two tubular masts are used, and when the depth is not too great serve for ventilation; if the depth is greater than the height of the mast, the air-reservoirs permit submersion for 48 hours. The first trials have been satisfactory. A. S.

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974. *Diesel Heat Motor.* (Electrical World, 31. p. 242, 1898.)—This new gas-engine, designed on a novel principle, and giving remarkable results, was described by Rudolph Diesel at a meeting of the Deutscher Ingenieure Verein, on June 16, 1897. He set forth four essential conditions for an economical engine in which the combustion takes place inside the working cylinder:—

1st. The temperature of combustion must be generated, not by and during the burning of the fuel, but before and independent of it, by mechanical compression of air. 2nd condition of this rational motor is, that the temperature of combustion is obtained directly by adiabatic compression of the air. 3rd condition, that the fuel must be introduced gradually into this compressed air in such a manner that the heat generated by gradual combustion (isothermally) is converted into work by the expansion of the air and gases without increasing pressure, similar to the admission pressure on the indicator diagram of a steam-engine, the point of cut-off being initiated by the stopping of the fuel supply. The burnt gases then expand adiabatically to the point of release, and

fresh air is again compressed adiabatically to the temperature of ignition before the introduction of the new charge. 4th condition, that the combustion should be carried on with a considerable excess of air, instead of with as little surplus as possible.

The Diesel experimental engines so far constructed have been of the single-cylinder four-cycle single-acting vertical type. One of 20 horse-power, working with refined petroleum, was tested by Professor Schröter in 1897. The engine-cylinder is water-jacketed, and provided with valves, operated by cams, for admission and exhaust. A small pump keeps an auxiliary vessel filled with air compressed to a higher pressure than that obtained in the cylinder. This air, compressed to about 40 atmospheres, serves to start the engine and inject the fuel. The indicator diagrams are similar to those of a steam-engine with admission pressure of 35 to 40 atmospheres, and early cut-off. The mean speed during the test was from 154 to 172 revolutions per minute. The ratio of the indicated work during compression to that during expansion showed an average of about 50 per cent. for full and half loads. The mean effective pressure in the working cylinder was about 100 lbs. per square inch at full load, and 70 lbs. per square inch at half load. The mechanical efficiency, that is the ratio of the brake or effective work to the indicated work, varied from 75 to 58 per cent. as the work was varied from full to half load. The consumption of petroleum per brake horse-power was about 0·24 kilogram (0·53 lb.) at full load, and 0·28 kilog. (0·61 lb.) at half load. Tests of the calorific value of the fuel showed that from 22 to 25 per cent. of the available energy of the fuel was converted into useful work on the brake. W. R.

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975. *Use of Exhaust Steam.* **A. H. Perkins.** (Elect. World, 31. p. 438, 1898.)—The author calculates the percentage of extra steam required in an engine, as the back pressure is raised above that of the atmosphere. From these calculations it is readily seen when it is economical to use exhaust steam for heating or drying, or when it is better to heat with live steam. It will not pay to use exhaust steam unless the amount so used for heating exceeds the quantity of extra steam required on account of raising the back pressure. The author discusses a case in which exhaust steam from a Buckeye engine was used to heat 13 driers, in which case the heating by direct steam showed a saving as compared with heating by exhaust steam. A. S.

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976. *Failure of Copper Steam-Pipes.* **J. T. Milton.** (Mech. Eng. 1. pp. 478–480, 511–513, 1898.)—An inquiry into the cause of an explosion of a copper steam-pipe on the s.s. 'Prodano' in June 1897, was held in August 1897, before three Commissioners in London. The findings of the Court are given and are discussed by Mr. J. T. Milton, the chief engineer to Lloyd's

Registry, who also gives a list of exploded steam-pipes which have been inquired into under the Boiler Explosions Acts. Professor Arnold made a micro-chemical determination of the causes which led to the explosion, and comes to the following conclusions:—(1) That the brazing of the 'Prodano's' pipe was originally sound, of good workmanship, and composed of a suitable alloy. (2) That the explosion was due to a gradual removal from the greater part of the brazing of about half its zinc, the remainder being converted into oxide, and thus leaving a spongy, and hence brittle, mass of metallic copper possessing little cohesion. (3) That the disintegration described above was electrolytically brought about by the presence in the pipe of water containing small quantities of fatty acids which formed organic salts of zinc, either fusible at the temperature of the pipe or soluble in hot water. (4) That the fatty organic acids must have reached the main steam-pipe *via* the piston-rods, cylinders, condensers, and boilers, and that fatty oils must have been employed either inadvertently as adulterations in mineral oil, or deliberately in the form of lubricants, such as tallow or castor-oil. A. S.

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977. *Variable Efficiency of Steam Boilers.* **F. G. Gashe.** (Indus. & Iron, 23. p. 421, 1897; 24. pp. 148–149, 167–168, & 183–185, 1898.)—When the temperature of the combustion-products is lowered to that of the steam, it is evident that all the available heat has been utilised. The prevalent methods of conducting boiler-trials do not recognise sufficiently the important influence of the rate of combustion of the fuel. The average rates of supply of feed-water and fuel over the portion of the trial during which they are uniform should be taken, instead of the totals over the whole period. $E' = C/1 + AR'$; where E is the evaporative power, C and A constants, and R′ the fuel per square foot of grate surface. The results of 16 trials on a 72 in. × 20 ft. horizontal tubular boiler are given. The performance of a boiler should be derived from a series of trials in which the rate of combustion is deliberately varied. Intimately connected with boiler-performance is that of the feed-heater.

The paper is followed by a discussion. A. S.

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978. *Water-Tube Boilers.* **G. Haliday** and **R. Seabury.** (Indus. & Iron, 24. pp. 366–367 & 428–429, 1898.)—A paper read at the Institute of Marine Engineers, in which most of the commercial types of water-tube boilers are described and discussed. A. S.

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979. *Steam Consumption of Auxiliary Apparatus of U.S. steamer 'Minneapolis.'* (Elect. World, 31. p. 383, 1898.)—The apparatus for testing the auxiliaries was primarily arranged to find the steam-consumption of the dynamo engines, the pistons of which

had no packing-rings but were grooved for water packing. The engines were afterwards supplied with new pistons and packing-rings. The steam-consumptions before and after the change were respectively 123 lbs. and 69 lbs. of steam per I.H.P.-hour. The steam per I.H.P.-hour on some of the auxiliary engines varied from 55 lbs. on a circulating pump-engine of 19 I.H.P., to 319 lbs. for a duplex fire-pump of 0·8 I.H.P. A. S.

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980. *Steam Value of Three Kinds of Coal.* **A. Baldasano** and **W. J. Beach.** (Street Rly. Journ. 14. p. 199, 1898.)—The paper contains tables and diagrams of data and results of experiments made on a Babcock and Wilcox boiler. The boiler efficiencies at different rates of combustion were measured. In all three tests the evaporation is greatest with the lowest rate of combustion, an increase in the rate of combustion shows a diminution in the rate of evaporation; but in two out of the three cases a still higher rate of combustion increases the rate of evaporation. A. S.

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981. *Safety Devices for Steam and Power Plants.* (Street Rly. Journ. 14. pp. 291–292, 1898.)—A description (1) of the 'Monarch' *engine stop*, which is attached to the stem of the throttle-valve by means of a sprocket-chain, and is operated by pressing a push-button, any number of which can be placed in different positions as required; and (2) of the 'Monarch' *speed-limit*, in which two governor-balls are arranged so that when a predetermined speed is reached, an electric circuit is closed, bringing into action the engine stop and shutting down the engine at once. A. S.

DYNAMOS, MOTORS, AND TRANSFORMERS.

982. *Non-Insulation of Bolts in Armatures.* **J. Fischer-Hinnen.** (Ind. Elect. 7. pp. 105–107, 1898.)—It is generally believed that the non-insulation of the extremities of bolts which traverse the stampings of armatures may lead to losses of energy, since a closed circuit is formed by the bolts and the two-end stampings of the armature. The author investigates the subject theoretically, purposely assuming conditions most likely to give exaggerated results, and finds that in the case of 180 kilowatt machine the loss due to six bolts is only 5·3 watts. He concludes, therefore, that the loss is in general negligible. W. G. R.

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983. *Commutator Sparking.* **T. Reid.** (Amer. Instit. Elect. Engin. 15. pp. 33–60, 1898.)—The author considers that the theory that injurious sparking is due to the current sparking across the gap between the brush and the receding segment, by reason either of incomplete reversal of the current or of over-reversal, is insufficient, and attempts to show that sparking from either of these causes may be harmless, and that the real injury is done before the segment leaves the brush. Perfect commutation may be defined as a complete reversal of the current in the coil under commutation in such a manner that the portions of the current flowing through the two segments to which the ends of the coil are connected, shall be proportional to the respective contact areas of the segments. There are various ways in which imperfect commutation may occur. If the current across the contact surface of the receding segment does not decrease as rapidly as the contact-surface decreases, the current-density will increase and will be a maximum at the last part of the segment that touches the brush. More energy is concentrated at that point than at any other, and it will be raised to the highest temperature. This temperature may be high enough to melt or volatilize the copper of the segment; when the brush leaves the segment, the current continues to flow through the film of melted copper and draws an arc. This is the injurious spark. The spark which occurs when the copper is not melted has no injurious effect. The same thing may occur at the entering edge of the segment, but in this case no spark will appear: the melted copper will be carried along by the brush and the entering edge of the segment is gradually eaten away. The reversal E may be large enough, not only to reverse the current in the coil under commutation, but to increase it beyond the value of half the brush-current. In this case, since the receding segment is reducing its area while the current is increasing, that segment will get hottest. The variation of the brush-contact resistances aids the reversal of the current; as soon as this current becomes greater than that

which flows through the armature, the excess current must pass across the contact areas of both the segments under the brush. These two contact surfaces are in series as regards this current, and the lowest possible resistance they could have, would be when the brush covers an equal surface on each segment. The resistance of this part therefore starts at infinity, decreases to this minimum, and goes back to infinity again. If there were no contact-resistance the current would reach its normal full-load value at about the middle of the commutation period, assuming that the reversal E is able to reverse the current at full load without the aid of the contact-resistances. In fact the reversal E does a very small part of the reversing at full-load when the inductance is small compared with the contact-resistances. There are two ways by which sparkless commutation may be assured: by increasing the brush contact-resistance, or by decreasing the impedance. The limitation of the first of these conditions is the heating of the commutator. The increasing use of the carbon brush is thus explained by the fact that the contact-resistance of carbon on copper per square inch is much greater than that of copper on copper.

In the discussion on Reid's paper, **G. S. Dunn** says that he considers that the resistance of the brush affects commutation more than the contact-resistance of the brush on the commutator. A carbon brush which will stop sparking on a 25 H.P. motor wound for 110 volts, will not stop sparking when the same motor is wound for 500 volts. But a graphite brush, or carbon brush of much higher resistance will stop it. Where a copper brush will not stop sparking on a 110-volt dynamo a copper gauze brush will, because of the higher resistance of the gauze, not because of the diminished contact area resulting in higher contact-resistance.

Dunn proposes a method of dividing the reactance of the armature into its inductive and ohmic terms. The armature is put into its bearings away from the influence of any field, the full-load current is passed through it, and the volts across the brushes measured. This gives the drop due to the ohmic resistance of the conductors and the contact-resistance of brushes. The armature is then driven at its full speed with the same current, the volts will go up, the difference after allowing for contact and brush resistance will give the reactance of the armature directly in volts. On 230-volt machines with carbon brushes, commutation will take place sufficiently well for heavy duty with a reactive voltage of 2 volts. If the machine is used for intermittent work and has to have its brushes in the middle, this may be increased to 5 volts. In 500-volt machines with graphite brushes, the reactive volts may be twice as high.

Steinmetz thinks that the friction of the brush must be considered; the C^2R loss varies with the load, but the friction loss is constant. In a 50-volt machine the friction loss may frequently be as much as 5 per cent. or more of the output

of the machine. He considers that with ordinary carbon brushes the internal resistance of the brush is negligible compared with the contact-resistance. The effect on commutation is very nearly the same whether the resistance is in the contact or internally. R. B. R.

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984. *Induction Motor.* **A. E. Wierner.** (Amer. Electn. 10. pp. 193–194, 1898.)—In this article is given a neat way of showing the motion of a revolving field, suitable for lecture purposes. By a kinetoscopic arrangement of sheets of paper containing diagrams of the rotary field in proper succession and exactly concentric with each other, a good representation of a revolving field may be obtained. When passing the sheets in one way the revolving field is seen to rotate in one direction, and on moving the sheets backward, the rotation is in the opposite direction. W. G. R.

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985. *Improving Power-Factor of Induction Motor.* (Elect. World, 31. p. 585, 1898.)—A brief notice, with some criticisms, of the arrangement recently patented by **C. P. Steinmetz** for increasing the power-factor of induction motors. In the case of a single-phase motor, a tertiary winding is provided on the core of the primary, and connected to a condenser. This winding is so arranged relatively to the primary as to be inoperative so long as the rotor is at rest. As soon as the latter is started, however, the reaction of the currents induced in its windings sets up an E.M.F. in the tertiary, and the condenser connected to the latter gives leading currents which react on the primary and secondary, and neutralise the "idle" currents in these circuits. A. H.

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986. *Current Transformers.* **C. T. Child.** (Elect. Engin. N.Y. 25. pp. 573–575, 1898.)—The author discusses the various methods of transforming alternating into continuous currents and *vice versa*. The use of rectifiers is restricted, on account of sparking difficulties, to comparatively small currents (10 amperes). Their efficiency is very high, but a serious disadvantage is the extra strain imposed on the insulation in consequence of the maximum potential difference considerably exceeding the R.M.S. value. If the transformation involves large currents, and if these are not to be fluctuating, one or other of the following 3 methods may be used:—(1) a dynamo driven by a synchronous motor; (2) a rotary transformer, with either single or double winding; (3) a machine of the type devised by Hutin and Leblanc, and called by them "panchahuteur." The 1st method has the advantage that the direct-current E.M.F. is independent of that of the alternating current, and may be adjusted through a considerable range if desired. Further, if the alternating current be fed into the stationary part of the motor, very high E.M.F.s may be used,

without the intervention of stationary transformers; and lastly, the frequency may be chosen without any reference to the direct-current end of the machine. The main disadvantages of the method are high cost and comparatively low efficiency. The method involving the use of a double-winding rotary transformer effects considerable saving in material; but many of the advantages which characterise the 1st method are sacrificed. Double-winding rotary transformers are not much used.

[*To be continued.*] A. H.

POWER DISTRIBUTION, TRACTION, AND LIGHTING.

987. *Regulation in Central Stations.* **W. H. Chapman.** (Amer. Electn. 10. pp. 206–207, 1898.)—This paper, after treating the subject of regulation generally, fully describes an arrangement successfully used by the author for preventing variations of voltage or current according as the basis of regulation is constant potential or constant current. The actual detector is a solenoid with a laminated plunger connected to one end of a lever, with a movable counterbalance weight at the other end; the movement of this lever closes a pair of electrical contacts at one side or the other. The connecting link between this detector and the regulating rheostat consists of two differentially wound solenoids having a common core; each solenoid has two similar windings, in one of which there is always current, hence the core is always magnetised and acted on by two equal and opposite forces. When the second coil is put in on either solenoid by the contact points of the detector, that solenoid is neutralised and the other moves the core, putting in or taking out resistance in the rheostat. By means of this arrangement all sparking caused by induction is effectually stopped. The paper contains a sketch of the above arrangement showing several ingenious devices for fine adjustment of the working parts. M. G. W.

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988. *Distribution of Electrical Energy in Paris.* **J. Laffargue.** (Elect. Engin. 21. pp. 519–523, 562–564, 627–629, 649–650, 1898.)—In the end of the year 1888 the Municipal Council of Paris granted concessions to certain companies for the distribution of Electrical Energy. The main conditions imposed were as follows:—The authority to lay cables in Paris was granted for 18 years, the mains everywhere to be underground. The tariff to be fixed by the company but not to exceed 14·4*d.* per kw. hour for lighting, and 6*d.* for motive power. Municipal dues amounting to £4 per annum for every kilometre of conduits laid and 5 % on returns to be paid. The area of supply to have form of a sector passing from the centre of the city to the circumference. Since 1888 six companies have taken up concessions, and the city of Paris has established municipal works at the Halles Centrales. A map is given in the article showing different areas of supply and the position of the stations. The author then describes the systems, etc. of the various companies.

Edison Continental Company.—The distribution is by continuous current with 3-wire feeders in ring circuits, with 120 volts between each. The company has 3 stations connected together in parallel, and a substation for accumulators. At the close of 1897 their available power was 3300 kw. in machines and 420 kw. in accumulators.

Société d'Eclairage et de Force par l'Electricité.—The principal station of this company is outside Paris, and besides supplying continuous current to works in the neighbourhood sends continuous current at 2500 volts into the city, which is transformed down by rotary transformers. The company owns several small generating stations in Paris and substations for transformers and accumulators: their total available power is 3820 kw. from machines and 290 kw. from accumulators.

This company has also recently undertaken to supply energy by diphase alternating currents from the works at St. Ouen.

Campagnie d'Air Comprimé et de l'Electricité.—The distribution was originally effected from about 20 substations drawing continuous current at 3000 volts from two generating stations connected in series. The company has now abolished most of the substations, and is supplying current at 500 volts direct to the distributing networks from a large new station. The total power at the new station is 3600 kw., and 2325 kw. at the two old works.

Municipal Works at the Halles Centrales.—These works are chiefly for the purpose of public lighting, but a few private consumers are supplied; they have a direct-current distribution at 120 volts, and an alternating system at 2400 volts which is transformed down to 220 volts. The total available power is 325 kw. in continuous, and 330 kw. in alternating machines.

Société de la Place Clichy.—The distribution is by the 5-wire system with accumulator and regulating stations; at their generating station the company have at their disposal machines yielding 2300 kw. Data of some interesting experiments with anthracite coal made at this station are given in the paper.

Société du Secteur des Champs Elysées.—This company has a large district and has adopted alternating currents at 3000 volts with transformers for each consumer; it has one central station, producing 1800 kw. The distributing cables are armoured and laid direct in the ground. The company has 50 motors equivalent to 220 H.P. connected to its mains.

Société du Secteur de la Rive Gauche.—This company did not commence work until 1896; it has one generating station outside Paris, and distributes its energy by alternating currents at 3000 volts with transformers in substations or on the consumers' premises. The power at present installed is 1600 kw., but the company is extending rapidly.

In conclusion the author states that the total power available at the works in 1896 was 17,775 kw. from machines and 1610 kw. from accumulators, and adds tables as to existing charges, etc. The article is well illustrated by photographs. M. G. W.

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989. *Cost of Electrical Energy.* **R. Hammond.** (Journ. Inst. El. Eng. 27. pp. 246–378, 1898.)—The author gives a large number of data relating to the working of about 80 existing stations

in Great Britain and Ireland. Twenty tables and eleven diagrams are included in the paper. The tables deal with costs per unit, the order of merit of the various stations in relation to different items of cost (coal; oil, waste, water, and stores; wages; repairs and maintenance; rent, rates and taxes; management), comparison of costs, load factor, units used in distribution, variation of cost with the number of units sold, depreciation, etc. The diagrams embody the tabular results in a more convenient form. If the most favourable features of each works were reproduced in one, the energy would be produced and distributed for 0·84*d.* per unit. The various factors in the reduction of cost are considered, viz.:—output, load-factor, reliability of plant, the engineer factor, efficiency of generating plant, efficiency of distribution, and all-round efficiency. The author concludes with a prophecy that when the output at Leeds reaches 5,000,000 units per annum, the works costs will fall to 0·50*d.* and the total costs to 0·75*d.* per unit. It is impossible to more than indicate the scope of this paper in an abstract. W. R. C.

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990. *Power Transmission at Delta, Pa.* **G. R. Stubbs.** (Eng. News. 39. p. 250, 1898.)—This paper describes the plant put down by the Delta Electric Power Co. at the Gartridge Falls, 5½ miles from Delta, to supply power for working slate quarries in the neighbourhood and for lighting the town. A timber crib rock-filled dam 30 ft. high has been placed at the top of a rapid, giving an available head of 42 ft. at the power-house below. The dam is V-shaped in plan with a crest 120 ft. long, over which the flood water is discharged. The available power is estimated at 1000 H.P. The plant at present installed consists of two 24-in. McCormick balanced wheels on a horizontal shaft coupled directly to a two-phase brushless generator of 350 kw. The power is transmitted at 5000 volts along a pole-line comprised of four bare copper wires on porcelain insulators; the transmission loss over 5½ miles is about 10 %. The rate to power consumers is 25 dollars (£5 4*s.* 2*d.*) per H.P. year of 10-hour days. The total cost of the present plant has been about £6250, but when additional wheels and generators can be utilised a much better showing as to first cost per H.P. will be possible. M. G. W.

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991. *Blast-Furnace Gas for Electrical Power Transmission.* **W. H. Booth.** (Elect. Rev. 42. pp. 531–532 & 605–607, 1898.)—The author discusses the disposition of the energy supplied to a blast-furnace. The iron, at present considered the primary product, is run off at a temperature of 2800° F., carrying with it heat represented by 1½ per cent. of the total fuel. 3 per cent. of the fuel disappears in the carbon which enters into combination with the iron. Another 3 per cent. disappears in the slag. About 15,000 lbs. of gases per ton of iron leave the furnace at a temperature of 500° F., carrying heat representing 4½ per cent. of the fuel. This leaves about 88 per cent. of the total heat of the fuel carried off in a form not visible as temperature, and representing

the calorific value of the carbon monoxide which forms about 28 per cent. of the effluent gases. It would appear that the power which can be regularly and continuously obtained from a blast-furnace, is 10 H.P. per ton of coal per week; if about 10 million tons of fuel are used per annum in English and Scotch blast-furnaces, then about two million H.P. is running to waste. This power is located at about a score of centres, and might be transmitted by electricity to places where it could be economically used. The whole of the cotton-mills in the country would not absorb a fourth of the supply. There is no difficulty in igniting these poor gases in the cylinder of a gas-engine; gases too dilute to burn in the open, readily ignite when compressed. A. S.

992. *Blast-Furnace Gases for Motive Power.* **B. H. Thwaite.** (Elect. Engin. 21. pp. 594–596 & p. 623, 1898.)—The author refers to the competition between the three great iron-making countries—United States, Germany, and Great Britain—and to the necessity of improving the industrial procedure if we desire to keep on a level of equality with our foreign competitors. He has found during his prolonged investigations that great thermal economies can be effected in modern blast-furnace plant in the following directions: (*a*) in the combustion of blast-furnace gas for power development; (*b*) in the prevention of waste of gas during the charging operations; (*c*) in heating the air-blast with a reduced expenditure of gas; (*d*) in preventing the entrance of dust into the hot-blast stoves. He has applied the Thwaite-Gardner system of working blast-furnace gas in internal combustion engines at important works in France, Germany, and Great Britain. Whereas with blast-furnace gas-fired Lancashire boilers and good steam-engines, 400–500 cubic feet of blast-furnace gas is required to develop one horse-power hour, with the new system only 80–120 cubic feet are required; the economic advantages of the new system as compared with the old being as four to one. The thermodynamic efficiency of blast-furnace gas for power purposes is actually higher than town or retort gas. The financial value depends on local conditions, but if a demand for power for lighting or other purposes exists within a radius of 30 miles of the iron-works, it can be profitably supplied. The available power has also been applied by the author to the driving of existing blowing-engines. A. S.

993. *Blast-Furnace Gases for Motive Power.* **A. Greiner.** (Elect. Engin. 21. pp. 660–661 & p. 690, 1898.)—A 200-H.P. engine using blast-furnace gas has been running at the Seraing works of the Cockerill Co. The author compares the utilisation of blast-furnace gas in steam-boilers and in gas-engines, and concludes that the blast-furnace gas is the greatest and surest source of power existing; a surplus of 2000 H.P. per 100 tons of pig-iron produced per week, lying ready to hand.

Objections have been offered to the use of blast-furnace gas in gas-engines on account of the dust carried by it, acid matters, and

the irregularity of its composition. These objections are discussed, and the author concludes they have little or no weight; remarking that "it is no more requisite to use thoroughly clean gas in a gas-engine than it is to use distilled water in a boiler." A. S.

994. *Electricity on a Modern Warship.* **G. H. Shepard.** (Eng. Mag. 15. pp. 280–288, 1898.)—A discussion of the relative advantages of steam-engines and electric motors for the auxiliaries on board a warship. The author's conclusion is that although electric auxiliaries offer many advantages, their great cost and necessary space render them a doubtful benefit, while their great weight absolutely rules them out. But with continued progress, both by makers and users of electric machinery, it will be gradually more and more adopted for special purposes on board ship. A. S.

995. *Electric Conduit Tramway.* (Electrician, 41. pp. 141–144, 1898.)—A short account is given of the New York Electric Tramway, which was recently completed, with illustrations of the work in progress. A. H. A.

996. *Chicago Elevated Railway Plant.* **J. R. Cravath.** (Elect. Engin. N. Y. 25. pp. 475–481, 1898.)—An account is given of the South Side Elevated Railroad of Chicago, U.S.A., on which electricity is being substituted for steam. The generating station, of which illustrations are given, is equipped with plant rated at 3200 kilowatts output; a large cooling tower is provided, in which the condensing water is sprayed over sheets of wire netting, and exposed to an artificial draught of air. The third-rail system is used on the line, the rail being placed at one side of the track and fed in sections from a heavy copper main with which the feeders are connected. Each section of rail is supplied through a circuit-breaker, so as to confine the effect of a short circuit to one section. In the yards and shops, where the third rail is inadmissible, an overhead wire is used, making contact with a trolley of arched brass rod 14½ ins. high on the top of each car; the rod is balanced in a vertical position, and yields to the trolley-wire automatically without requiring attention. The Sprague multiple unit system is employed on the trains (see Abstract No. 344). The old cars are being converted by replacing one truck on each car by a motor truck; the change is being made by degrees, without interruption to the train service. A. H. A.

997. *Cable and Electric Traction in Chicago.* (Rly. World, 7. pp. 111–112, 1898.)—The more frequent the service on a cable line the lower the working expenses per car mile, while on an electric line the expenses per car mile fall off comparatively little by increasing the service. The present cost on the cable lines is 5¼*d.* per car mile, which is wonderfully low considering the high wages to be paid. The cost on the electric lines is 6¼*d.* per car mile. A. S.

998. *Electric Cableways.* **R. Lamb.** (Amer. Instit. Elect. Engin. 15. pp. 3–32, 1898.)—The author describes an electric cableway which has been applied to timber-logging in swamps which would be otherwise quite inaccessible, and to towing canal-boats. The system consists of a carriage with grooved wheels in tandem that moves on the suspended cable. From this carriage is hung a frame pivoted so that it always maintains a vertical position. The frame holds an electric motor geared to an elliptically grooved sheave, around which is wrapped two or three times a steel cable anchored at both ends. The upper or weight-bearing cable carries the electric current which passes through the motor, thence along the traction cable back to the generator. At intervals along the line connection is made between the traction cable and the ground. In logging-plants an electric crane is carried by the carriage.

The paper is followed by a discussion. A. S.

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999. *Waterloo and City Railway.* (Rly. World, 7. pp. 189–192, 1898.)—This paper gives a short account of the construction of the tunnels, the electrical equipment, and the rolling stock. A. S.

1000. *Automobilism.* **P. Simon.** (Électricien, 15. pp. 178–180, 197–199, 250–252, 1898.)—The author gives a simple formula applicable to vehicles whose speed does not exceed 25–30 kilometres per hour,

$$F = PV(K + \tan \alpha),$$

in which P is the total weight of the vehicle and its load, V the speed in metres per second, K the coefficient of traction on the level, α the angle the road-surface makes with the horizontal. He discusses in detail the values which should be taken for the various coefficients, and concludes that a fair average for $(K + \tan \alpha)$ is 0·06. With a maximum speed of 20 kilometres per hour, 4·5 horse-power is required per ton weight; the power along the level being 1·7. These are the powers actually required at the driving-wheels. The author then discusses the relative advantages of steam-engines, oil-engines, and electric motors for auto-cars. A. S.

1001. *Hopcraft's Pneumatic Railway.* (Engineer, 85. p. 328, 1898.)—A working model railway, one-tenth of a mile long, has been made on the system of direct pneumatic propulsion involving the use of no motive mechanism on the vehicle. A motor-tube of heavy canvas, with an inner air-tight tube of india-rubber, which in its normal position lies quite flat, is fixed on a supplementary rail of timber between the ordinary rails. Air under pressure is admitted to this tube, inflates it, and presses against a rubber-tired wheel which can revolve freely on an axle at the centre of the car, and which forms an air-tight joint between the two sections of the tube. A powerful propelling-force is thus exerted against the wheel, causing the car to travel at a speed limited only by the speed of the air in the tube. ——— A. S.

1002. *New Steam and Electric Truck.* (Street Rly. Journ. 14. p. 291, 1898.)—A description of a pressed steel truck for steam and electric railway purposes, introduced extensively within the last year by the John W. Cloud Co. and the McGuire Manufacturing Co. A. S.

1003. *Gas-driven Electric Light Station.* (Lightning, 13. pp. 162–163, 1898.)—The novel feature in this installation is the high-speed vertical gas-engine coupled direct to dynamos supplying 600 amperes at 110 volts for glow-lamps and Jandus arcs without fluctuation in the light. Three combined sets of engines and dynamos stand within a floor-space of 13 feet 6 inches by 8 feet. There is given a photograph of an engine-house, and a drawing showing the working parts of the gas-engine in section. The gas-engine has no valves, and the explosions take place inside the hollow piston. The connecting-rod is double, one rod revolving about the other and rotating the piston in the cylinder through 360 degrees once every two strokes. This combined rotary and reciprocating motion brings the two holes in the piston opposite the admission and exhaust ports, besides distributing the lubrication well and causing even wear of the piston. The engine speed is 560 revolutions per minute; so that there are about 280 explosions per minute. Two 3-feet flywheels, each weighing 5 cwt., with an adjustable 'hit-or-miss' governor, suffice to keep the velocity constant within the desired limits. There are also two batteries of E.P.S. accumulators to take the night and Sunday loads, and to guard against stoppage by the bursting of an ignition-tube. The maximum charge is 6*d.* a unit, and 'reduction on taking a quantity.' W. R.

1004. *Enclosed Arc Lamps.* **J. H. Hallberg.** (Elect. Rev. N.Y. 32. p. 296, 1898.)—This paper gives some practical details as to the cleaning and trimming of these lamps, including a method of removing deposits from the inner globes. C. K. F.

1005. *Davy Arc Lamp Hoisting Gear.* (Electrician, 41. pp. 176–177, 1898.)—This gear provides for isolating the lamp from the circuit when it is lowered for trimming, and also for obviating the necessity of opening the door of the post-chamber. The lamp is provided, at the top of the casing, with insulated contact-rings which, when the lamp is raised, engage with spring-contacts arranged in a hood on the post-bracket. Special pawls and a ratchet-wheel are provided for locking the winch for the steel suspension rope, so that the winch-barrel is released when the key is in position. A number of clear detail drawings and a photograph of the gear are given in the original paper. C. K. F.

1006. *Incandescent Lamp Efficiency.* **F. W. Willcox.** (Elect. World, 31. pp. 582–583, 1898.)—A paper very similar to that referred to in Abstract No. 224. A. H.

TELEGRAPHY AND TELEPHONY.

1007. *Cable Relay.* **K. Gulstad.** (Elect. Rev. 42. pp. 751–754, 1898.)—By a special arrangement of condensers and connections, it is proposed to convert any polarised double-current relay into a relay for cable signals. The usual source of insensitiveness is in the magnetic attraction between the armature, or tongue, and the nearest pole-piece. This attraction can be done away with, and converted into a repulsion, by arranging the relay as an interrupter, so that the tongue vibrates at a certain rate between the contacts, *i. e.* the rate at which it is agreed to signal Morse 'dots.' As the result of experiment, the author has discovered the best method of 'tuning' the vibrator by the addition of condensers and resistances. It is found that for a given arrangement of condensers etc., the tongue is able to vibrate at one or other of two different rates; but the vibrations are stable for one condition only. When a marking current from the cable enters the relay it stops the vibrations of the tongue and holds it over against the contact-stop.

[The article is to be continued.] R. A.

1008. *Acoustic Telegraphy.* **E. Hardy.** (Comptes Rendus, 126. pp. 1496–1497, 1898.)—The paper describes a microphone adapted for submarine transmissions. A little disc of carbon is fixed at the centre of a vibrating plate. Rods (forming pivots) of carbon, with counterpoises to regulate the pressure, are placed round the disc, a small quantity of mercury surrounding each pivot ensuring electrical contact. A. Gs.

1009. *Hertz Telegraphy.* **W. J. Clarke.** (Amer. Instit. Elect. Engin. 15. pp. 61–67, 1898; and Elect. Engin. N.Y. 25. pp. 391–393, 1898.)—These two papers describe the apparatus used by the author to demonstrate the system of telegraphy by Hertz waves. The apparatus, consisting of transmitters, coherers, and relays, has few points of novelty. Figures are given of instruments and connections. R. A.

1010. *Inductive Disturbances in Telephones.* **F. Laarmann.** (Elekt. Runds. 15. p. 132, 1898.)—The inductive disturbances in telephone circuits, due to variations of current in neighbouring electric-light mains, and to other causes, may be to some extent compensated by a method recently patented by Brockelt in Dresden. The primary of an induction-coil is placed in series with the telephone line-circuit; and the secondary of the same coil is connected as a shunt between two points in that circuit, so that the secondary currents oppose and neutralise the primaries.

Telephones are connected either two in series or two in parallel in the shunted portion of the line. Or another induction-coil may be inserted in the shunted portion; the primary being to line, and the secondary to the receivers. Experiment shows that by properly arranging the apparatus the telephone current is only slightly weakened by this device; very little alteration is required to apply it to existing systems, and it is claimed to be very effective. R. A.

1011. *Private Telephone Switchboards.* **Mandroux.** (Électricien, 15. pp. 136–139, 1898.)—A subscriber can call several others in conference, and conversations can be kept secret from the local operator (of the private installation) by Mors method now working five years at Mm. Meniers on the monocord principle. M. O'G.